Course descriptions

TABLE OF CONTENTS

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FJF-251/22	Accelerator Analytical Methods

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:

Learning outcomes:

Class syllabus:

Recommended literature:

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 0

A	B	C	D	E	FX
0,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Miroslav Ješkovský, PhD., Mgr. Jakub Zeman, PhD.

Last change:

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-240/22	Agrometeorology and Bioclimatology

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual works
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
Theory and practical applications of agrometeorology, forestry and human bioclimatology, microclimatology.

Class syllabus:
Microclimatic and agroclimatic subsystems, factors and processes acting in these subsystems. Materials used in microclimatology and agrometeorology. Agroclimatic and microclimatic ratios according to individual elements. Phenology. Agroclimatic conditions of Slovakia. The role of agrometeorology in plant protection. Agrometeorological and biometeorological forecasts. Forestry bioclimatology. The climate of the forest. The effect of air humidity on vegetation. Evaporation as a physical process and factors affecting it. Diseases and pests in agriculture and forestry. Human bioclimatology. The influence of individual climatic elements on living organisms. Thermoregulation, thermal comfort and discomfort. Climatotherapy, climatic baths.

Recommended literature:
Havlíček, V. et al.: Agrometeorologie. SZN, Praha, 1986
Šamaj, F., Prošek, P., Čabajová, Z.: Agrometeorológia a bioklimatológia. Vyd.UK Bratislava, Bratislava, 1994
Petrík, M. et al.: Lesnícka bioklimatológia. Príroda, Bratislava, 1986
Špánik et al.: Aplikovaná agrometeorológia. SPU Nitra, 1997

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 31

A	B	C	D	E	FX
70,97	19,35	9,68	0,0	0,0	0,0

Lecturers: RNDr. Ingrid Damborská, CSc., prof. RNDr. Milan Lapin, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-254/15	Air Pollution Control Technologies

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 10/90

Learning outcomes:
The student will gain an overview of existing conventional but also experimental technologies used to clean the air from gaseous pollutants and particulate matter.

Class syllabus:
Energy sources, production, demand and consumption. Sources and types of pollutants, their typical concentrations and air quality standards. Oxides of nitrogen (NOx), sulfur (SOx) and carbon (COx), methane (CH4), ozone (O3) and hydrocarbons (HC) - their basic properties and sources. Particulate matter (PM) - history, categorization and mechanisms of formation. Global environmental problems - greenhouse effect, acid rain, photochemical smog. Kyoto Protocol, Paris Climate Agreement and other climate conferences.
Pollutant prevention technologies. Fuel selection, treatment and purification, combustion temperature control, boiler configuration, non-stoichiometric and multi-stage combustion, flue gas recirculation, etc.
Pollutant reduction and removal technologies and their principles. NOx / SOx: adsorption, absorption, selective catalytic reduction (SCR). COx: sequestration, biochar, artificial weathering. CH4: steam and dry reforming. O3: adsorption, thermal and catalytic decomposition. HC: biofiltration, condensation, adsorption, thermal and catalytic oxidation. Particulate matter (PM): gravity settling chambers, cyclones, wet scrubbers, fabric filters, electrostatic precipitators. Mobile sources of pollution: emission standards, parameters affecting emissions, performance and consumption. Three-way and oxidation catalyst and diesel particulate filter (DPF), SCR and AdBlue.
Pollutant removal by electric discharges and hybrid plasma and catalyst systems. Process efficiency, carbon balance, selectivity. Commercial and industrial applications for air purification and deodorization for static and mobile applications.

Recommended literature:

K. Wark: Air pollution - Its origin and control, Addison-Wesley (1998)
K. C. Schifftner: Air pollution control equipment selection guide, Lewis Publishers (2002)
J. Hagen: Industrial catalysis - A practical approach, Wiley (2006)
K. B. Schnelle, et al.: Air pollution control technology handbook, CRC Press (2016)

Languages necessary to complete the course:

Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution

Total number of evaluated students: 27

A	B	C	D	E	FX
48,15	37,04	14,81	0,0	0,0	0,0

Lecturers: doc. RNDr. Karol Hensel, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-212/15	Application Software in Meteorology

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: independent work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Programming and software skill improvements oriented to the meteorology and climatology fields running under the UNIX operating system, LaTex formatting language.

Class syllabus:
Data visualization, GRADS and other software for plotting meteorological and climatological fields. FORTRAN programming language, scripting, programming in UNIX system. Command interpreters, shell. Fortran language concepts, syntax, types of variables - their declaration, operations with variables, fields. Arithmetic expressions, standard – intrinsic functions, logical operations, assignment statement. Formatted description, input-output commands, namelist, unconditional jump statement… Subroutines, functions and subroutines, global variables. Independent creation of short programs.
Programming of physical processes, e.g. advection, vertical stratification of the atmosphere.
Text editors (LA) TEX, software for writing scientific papers. Text processing and manipulation and work with large files.

Recommended literature:
Programovací jazyk FORTRAN 77 a vědeckotechnické výpočty / Jiří Hřebíček. Praha : Academia, 1989
Základy programovania fyzikálnych problémov : (programovací jazyk FORTRAN) / Ľudovít Fischer. Bratislava : Univerzita Komenského, 1982
Operační systém Unix a jazyk C / Jan Brodský, Luděk Skočovský. Praha : Státní nakladatelství technické literatury, 1989
Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques / C. A. Fletcher, Springer 2005, 401 pp.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 9

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Martin Gera, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAI/2-MXX-133/23	Artificial Intelligence for Everyone

Educational activities:
Type of activities: training session / course
Number of hours:
per week: 9 **per level/semester:** 1t / 117
Form of the course: on-site learning

Number of credits: 6

Recommended semester:

Educational level: I.II., II.

Prerequisites:

Course requirements:

Learning outcomes:

Class syllabus:

Recommended literature:

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 22

A	B	C	D	E	FX
45,45	36,36	4,55	9,09	4,55	0,0

Lecturers: prof. Ing. Igor Farkaš, Dr.

Last change:

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-112/00	Atmospheric Boundary Layer Physics

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual works
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
The student will gain basic knowledge of the processes taking place in the ground and boundary layers of the atmosphere, which he will be able to use in a number of applications (e.g. air pollution issues, flow modelling).

Class syllabus:
Earth's atmosphere. Turbulent state of the atmosphere, vertical transfer of substances in a turbulent atmosphere, turbulence criteria. Prandtle's theory of turbulent momentum transfer, length of mixing, roughness parameter, turbulent diffusion coefficient. The equation of turbulent diffusion. Vertical distribution of meteorological elements in the ground and boundary layers of the atmosphere. Methods for determining the characteristics of turbulence. Calculation of turbulent heat and water vapour flows in the ground layer of the atmosphere. The theory of the similarity of Monin and Obuchov. Taylor-Ekman spiral. Methods for determining the components of the radiation and energy balance. Determination of evaporation from the surface of soil and plants.

Recommended literature:
Gera, M., Tomlain, J., Damborská, I.: Fyzika hraničnej vrstvy atmosféry. Knižničné a edičné centrum FMFI UK, Bratislava, druhé rozšírené vydanie, 2011, 176 s.
Stull, R.B.: An Introduction to Boundary Layer Meteorology. Springer, 1988, 670 p.
Pope, S.B.: Turbulent Flows. Cambridge University Press, 2000
Arya, P. S.: Introduction to Micrometeorology. Academic Press, 2001

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 49

A	B	C	D	E	FX
71,43	6,12	16,33	4,08	2,04	0,0

Lecturers: RNDr. Ingrid Damborská, CSc., prof. RNDr. Milan Lapin, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-242/22	Aviation Meteorology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: II.

Prerequisites:

Antirequisites: FMFI.KAFZM/2-FMK-242/00

Course requirements:
Preliminary evaluation: individual work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
The result of the training is a preparation of experts for the meteorological provision of civil aviation, as the largest user of meteorological services.

Class syllabus:
Basics of aeronautical meteorology. Significant meteorological phenomena in aviation. Airplane navigation. Air transport services. Aircraft operation. Organization of aviation meteorological services at international level. Meteorological observations and information distribution systems for airports. Meteorological observations at airports. Significant weather information. Distribution of information. Data archiving and quality control. Activities of the Meteorological Office.

Recommended literature:
Letecká meteorologie / Petr Dvořák. Cheb : Svět křídel, 2004
Slovenský letecký slovník : terminologický a výkladový / Milan Nedelka ...[et al.]. Bratislava : Magnet Press, 1998

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 5

A	B	C	D	E	FX
20,0	60,0	0,0	20,0	0,0	0,0

Lecturers: Mgr. Alexandra Varsányiová

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FBF-202/00	Bioenergetics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:

Learning outcomes:

Class syllabus:
The first and second theorems of thermodynamic and biological systems. Gibbs energy, coupling of chemical reactions. Entropy of open thermodynamic systems. Entropy and information. The meaning of biological arrangement. Biological system, cell, organelles (mitochondria). Macromolecules in bioenergetics. General principles of metabolism. Glycolysis, formation of acetylcoenzyme A, Krebs cycle, electron transport chain complexes in mitochondria and their inhibitors, the relationship between respiration and energy production. Membrane transport. Quantitative bioenergetics, driving force ratio, redox and electrochemical potential, experimental determination of mitochondrial function. Enzymes and kinetics of enzyme processes. Substrate phosphorylation. Membrane phosphorylation - chemical concept. Mitchell's chemiosmotic concept. Conformational concept of membrane phosphorylation. Photosynthesis.

Recommended literature:
Bioenergetics: its thermodynamic foundations / Lars Garby, Poul S. Larsen. Cambridge : Cambridge University Press, 1995. ISBN 10: 0521066352
Bioenergetics 4 / David G. Nicholls, Stuart J. Ferguson. London : Academic Press, 2013. ISBN: 9780123884251
Biological physics : energy, information, life / Philip Nelson ; with the assistance of Marko Radosavljevic and Sarina Bromberg. New York : W. H. Freeman, 2004. ISBN 0-7167-4372-8
Molecular Biology of the Cell / Bruce Alberts et al. W. W. Norton & Company; 6th edition, 2014. ISBN-10: 0815345240

Languages necessary to complete the course:

Notes:

Past grade distribution Total number of evaluated students: 51					
A	B	C	D	E	FX
84,31	9,8	3,92	0,0	1,96	0,0
Lecturers: prof. RNDr. Iveta Waczulíková, PhD., Mgr. Veronika Šubjaková, PhD.					
Last change: 22.06.2022					
Approved by: prof. RNDr. Zdenko Machala, DrSc.					

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-157/22	Catalysis and Green Applications

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 10/90

Learning outcomes:
The student will gain an overview about different types of catalysis and catalysts and their importance in industrial processes.

Class syllabus:
Introduction to catalysis. Classification of catalysts, their activity, selectivity and stability. Homogeneous catalysis - principles, acid-base, redox and elimination reactions. Catalytic cycles. Soft and hard catalysis. Industrial processes of homogeneous catalysis. Biocatalysis - enzymatic reactions. Heterogeneous catalysis - principles and kinetics. Catalyst efficiency. Deactivation and regeneration. Physical and chemical properties of heterogeneous catalysts. Zeolites. Industrial processes of heterogeneous catalysis. Manufacture of chemicals. Electrocatalysis - principles, fuel cells. Environmental catalysis and green chemistry. Automotive catalytic converter. NOx removal. Catalytic afterburner. Photocatalysis. Development, production and testing of catalysts. Catalytic reactors. Economic aspects of catalysis. The future of catalysis.

Recommended literature:
M. Bowker: Basis and applications of heterogeneous catalysis, Oxford Chem. Press (1998)
J. Hagen: Industrial catalysis: A practical approach, Wiley (2006)
R. A. Sheldon et al.: Green chemistry and catalysis, Wiley (2007)
G. Rothenberg: Catalysis, Wiley (2008)

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 7

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Karol Hensel, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-238/22	Change and Variability of the Climate

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Antirequisites: FMFI.KAFZM/2-FMK-238/00

Course requirements:
Preliminary evaluation: elaboration of a paper on the solved issues and a final written test
Final exam: -
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
By completing the course, the student will gain knowledge of the theory and results of the research of natural climatic changes and variability and anthropogenically influenced climate change.

Class syllabus:
Climate changes, climatic variability, climatic cycles, and the “climate change” in the all Earth’s history and in the next centuries.
Instrumental and the other observations as the base for the climate changes, variations and variability research. Methods of studying climate change, variability and fluctuations. Climatic changes from the Pre-Cambrium up to the present. Climate change scenarios for the 21st century (natural and anthropogenically induced climatic changes due to the greenhouse effect increase). Climate change and change in the ozone concentration. Thermal and other atmospheric pollution, greenhouse gases and aerosols emission. Climate change and climatic variation forecasts, climate change scenarios (climatic scenarios by the IPCC).

Recommended literature:
Chrgian, A.Ch.: Fizika atmosfery, Tom 1, 2. Gidrometeoizdat, Leningrad 1978, 247 a 319 pp.
Frakes, L.A.: Climates Throughout Geologic Time. Elsevier Sci.Publ.Comp., Amsterdam, 1979, 310 pp.
Monin, A.C., Šiškov, A.J.: Istorija klimata. Gidrometeoizdat, Leningrad, 1979, 408
Peixoto, J.P., Oort, A.H.: Physics of Climate. AIP Press, Springer, New York 1992, 520 pp.
Lapin, M., Tomlain, J.: Všeobecná a regionálna klimatológia. Vyd. UK Bratislava, Bratislava 2001, 184 pp.

Pedlosky, J.: Ocean Circulation Theory. Springer, Berlin 1998, 455 pp.
Dobrovolski, S.G.: Stochastic Climate Theory. Springer, Berlin 2000, 282 pp.
IPCC (2013): Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, New York, 1535 pp.
The newest information from the INTERNET and journals.

Languages necessary to complete the course:
Slovak in combination with English.

Notes:

Past grade distribution
Total number of evaluated students: 4

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Marián Melo, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-119/22	Combustion and Thermochemical Processes

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By completing the course, the student will gain a comprehensive knowledge of energy fuels and their usability through combustion and thermochemical processes.

Class syllabus:
The importance of energy, the current state and forecasts of energy production and consumption. Classification and properties of energy fuels. Origin, properties and extraction of fossil fuels (oil, natural gas, coal, less valuable and substitute fuels). Biomass and its energy use.
Combustion as a thermochemical process, thermodynamics and kinetics of chemical reactions in the combustion process, chemical kinetic model, calculation methods applicable to the description of combustion processes, chemical and thermal analysis of reaction systems. Laminar premixed flame, laminar diffuse flame, droplet evaporation and combustion, turbulent premixed and diffuse flame, solid fuel combustion, imperfections of combustion processes and emissions (NOx, CO, VOC).
Layer combustion, grate combustion, fluidized bed combustion, flue gas recirculation, catalytic combustion. Internal combustion engine with internal and external combustion, types of engines (Otto engine, Diesel engine and other engines). Fuel technologies, fluidized bed combustion, gasification, pyrolysis, liquefaction, alcohol as fuel, electrochemical fuel cells and generators. Combined cycle. Combustion turbines. Utilization of waste as an energy source, plasma gasification, plasma assisted combustion.

Recommended literature:
D. A. Tillman: The combustion of solid fuels and wastes, Academic Press (1991);
S. R. Turns: An Introduction to Combustion: Concepts and Applications, McGraw-Hill Companies (2012);
H. H. Schobert: Chemistry of Fossil Fuels and Biofuels, Cambridge University Press (2013);
Stanislav Malík, Náhradné palivá v parných kotloch, Alfa SNTL (1988);

Š. Marko et al.: Energetické zdroje a premeny, Alfa (1988);
Pavel Augusta et al.: Velká kniha o energii, LA Consulting Agency (2001).

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 11

A	B	C	D	E	FX
27,27	45,45	27,27	0,0	0,0	0,0

Lecturers: Mgr. Richard Cimerman, PhD., prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Marcela Morvová, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB+KAFZM/2-FOZ-275/22	Complex Solutions of Environmental Problems

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 50/50

Learning outcomes:
The student will gain basic knowledge of environmental management and learn to look comprehensively on global and local environmental issues. Gain an overview of the various pollutants and their effects as well as the basics of environmental toxicology, including the most important laws in the area environmental and energy legislation, an overview of the best available technologies in all areas of the environment (air, water, waste, greenhouse compounds, pollution so that it is possible to comprehensively address the problems of specific sources of pollution. During semester the student processes the selected relevant topic and presents his solution to the environment problem.

Class syllabus:
Basic principles of environmental management, pollution control vs. Environmental management, environmental audit. Global and local environmental issues and complex looking at their solutions. The carbon cycle, the CO2 problem and the carbon footprint in terms of flows energy on earth. Comparing the carbon footprint of different processes, unconventional solutions.
Overview of atmospheric, water and soil pollutants and their effects on the environment, living organisms and humans. Fundamentals of environmental toxicology, including the necessary analytical methods. Selected environmental and energy laws and the main points of European environmental protection and energy policy and the possibilities of their implementation into practical economic life.
An overview of the complex impacts of different economic sectors (energy, industry, transport, agriculture) to the environment. An overview of the best and other available technologies for environmental protection according to source types of pollution and individual sources pollution. Synergistic effects and specific effects resulting from the combination of pollutants.

Recommended literature:

Pollution Prevention and Abatement Handbook, 1999, Manuál Svetovej banky pre obnovu a rozvoj, elektronická verzia

B. Smit, J.A. Reimer, C.M. Oldenburg, I.C. Bourg: Introduction to Carbon Capture and Sequestration, Imperial College press 2014

H. M. Stahr: Analytical methods in toxicology, Wiley, 1991, ISBN 0471851361, 9780471851363, je v príručnej knižnici oddelenia Env. Fyziky

Electronic books from environmental management and environmental toxicology

Topical presentations of students of previous years

Languages necessary to complete the course:

Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution

Total number of evaluated students: 32

A	B	C	D	E	FX
93,75	6,25	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Marcela Morvová, PhD., prof. RNDr. Milan Lapin, CSc.

Last change: 29.05.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-156/15	Computational Methods in Liquid Dynamics

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: independent work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Application of numerical procedures to solve meteorological and climatological problems.

Class syllabus:
Computer arithmetic, error propagation in calculations, interactive solution of nonlinear equations, interpolation, approximation of functions. Orthogonal Chebyshev and Legendre polynomials, discrete integral approximation, Newton-Cotes method, Gaussian integration. Determination of eigenvalues of selected matrices, diagonalization of matrices, compilation and solution of discrete forms of selected differential equations describing fluid dynamics, Initial value problem, nondimensional equation, solution of integral equations, issues of uniqueness, consistency, stability and thus convergence of the solution, Euler's method of solution diff. equations, Runge-Kutta methods, multistep methods, Predictor-corrector method. The topics are focused to solve problems in meteorology and climatology.

Recommended literature:
Numerické metody matematické analýzy / Petr Přikryl. Praha : Státní nakladatelství technické literatury, 1988
Základy numerické matematiky / Anthony Ralston ; přeložili z anglického originálu Milan Práger, Emil Vitásek. Praha : Academia, 1978
Theoretical Numerical Analysis, A Functional Analysis Framework / Atkinson, Kendall, Han, Weimin, Series: Texts in Applied Mathematics, Vol. 39., 3rd ed., Springer, 2009

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution Total number of evaluated students: 14					
A	B	C	D	E	FX
21,43	14,29	42,86	14,29	7,14	0,0
Lecturers: doc. RNDr. Martin Gera, PhD.					
Last change: 14.03.2022					
Approved by: prof. RNDr. Zdenko Machala, DrSc.					

COURSE DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KJFB/2-FOZ-141/22	**Course title:** Computer Modelling of Environmental Processes
Educational activities: **Type of activities:** lecture / practicals **Number of hours:** **per week:** 1 / 2 **per level/semester:** 13 / 26 **Form of the course:** on-site learning	
Number of credits: 4	
Recommended semester: 3.	
Educational level: II.	
Prerequisites:	
Course requirements: Preliminary evaluation: Final exam: oral / written Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 50/50	
Learning outcomes: The course introduces students to the basic model approaches used in the field of simulation of environmental processes and give basic programing skills useful for Monte-Carlo modeling in environmental physics.	
Class syllabus: Complex environmental system Random variables, Pseudo- random generators, modeling probability distribution Random walks Diffusion Cellular automata Lattice gas Environmental applications (river network, trees, earthquakes, ….)	
Recommended literature: Dirk P. Kroese, Thomas Taimre, Zdravko I. Botev, Handbook of Monte Carlo Methods, Book Series:Wiley Series in Probability and Statistics, Wiley 2011	
Languages necessary to complete the course: Slovak in combination with English (some of the suggested readings are in English).	
Notes:	

Past grade distribution
Total number of evaluated students: 8

A	B	C	D	E	FX
87,5	12,5	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Jozef Masarik, DrSc., doc. Mgr. Róbert Breier, PhD.

Last change: 11.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KEF/2-FTL-204/22	**Course title:** Diagnostic Methods in Solid State Physics
Educational activities: **Type of activities:** lecture **Number of hours:** **per week:** 4 **per level/semester:** 52 **Form of the course:** on-site learning	
Number of credits: 5	
Recommended semester: 3.	
Educational level: II.	
Prerequisites:	
Course requirements: The evaluation of the course has a form of an oral exam, grading of which reflects the overall orientation of the student in the covered topics. Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%. Scale of assessment (preliminary/final): 0/100	
Learning outcomes: By completing the course, students will gain an overview of selected analytical, spectroscopic and microscopic methods used for studies of solids in terms their structure, composition, surface topography and other properties.	
Class syllabus: Electron and ion optics, types of analyzers for analytical and spectroscopic methods. Principles and description of methods: - X-Ray photoelectron spectroscopy, Auger electron spectroscopy, UPS, IS - X-ray and electron diffraction, small angle scattering and related methods - Scanning and transmission electron microscopy and related methods (EDX, WDS, FIB) - Scanning probe microscopy (STM, AFM, EFM, MFM, SSRM, KPFM) and others.	
Recommended literature: Elektronová spektroskopia : Metody analýzy povrchů / F. Allmer ...[et al.]; editorka Ludmila Eckertová. Praha : Československá akademie věd , 1990 V.Valvoda, M.Polcarová, P. Lukáč, Základy strukturní analýzy, Karolinum, Praha, 1992, pp. 492, ISBN 80-7066-648-X J. M.Zuo, J. C.H. Spence, Advanced Transmission Electron Microscopy, Springer, New York, NY, 2017, ISBN 978-1-4939-6605-9 J.F. Watts, J. Wolstenholme, An introduction to surface analysis by XPS and AES, John Wiley & Sons, 2003, pp. 212, ISBN 978-0-470-84713-8 Scanning probe microscopy and spectroscopy, ed. D.A.Bonnel, John Willey & Sons, New York, 2001, pp. 493, ISBN 0-471-24824-X	

M.Birkholz, Thin film analysis by X-ray scattering, Wiley-VCH Verlag GmbH, Weinheim, 2006, pp. 356, ISBN 3-527-31052-5
T.L.Alford, L.C.Feldman, J.W.Mayer, Fundamentals of Nanoscale Film Analysis, Springer, 2007, pp. 336, ISBN 978-0-387-29260-1
E.Mayer, H.J.Hug, R.Bennewitz, Scanning Probe Microscopy: The Lab on a Tip, Springer, 2004, pp. 210, ISBN 3-540-43180-2

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 56

A	B	C	D	E	FX
58,93	28,57	8,93	3,57	0,0	0,0

Lecturers: doc. Ing. Maroš Gregor, PhD., doc. RNDr. Tomáš Plecenik, PhD., doc. RNDr. Tomáš Roch, Dr. techn., Mgr. Leonid Satrapinskyy, PhD., Mgr. Branislav Grančič, PhD.

Last change: 03.12.2021

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-920/22	Diploma Seminar (1)

Educational activities:
Type of activities: seminar
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual work
Final exam: oral presentation, final evaluation
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
By completing the seminar, students will be able to categorize scientific literature and perform analysis and synthesis of knowledge gained from the literature and master the methods of working on a professional project related to the topic of their thesis.
Students will prepare for writing their diploma thesis, learn the methodological procedures of preparing a diploma thesis, gain an overview of the current state of literature on the topic of the diploma thesis, learn the methodology of scientific work, processing and evaluation of results.

Class syllabus:
Methodical procedures for elaboration of the structure and time schedule of the assigned project; work with professional literature; methods of obtaining data. Written processing of the assigned topics according to specific thesis assignments.
From the students: clear formulation of the content and objectives of the work, solutions, analysis of ambiguities, partial presentations of results on the assigned topic of the thesis. Joint interactive analysis of individual performances and critical discussion.
Gradual presentation of the state of development of diploma thesis of individual students. Discussion of used methods, results, and literature review.

Recommended literature:
Ako písať vysokoškolské a kvalifikačné práce : Ako písať seminárne práce, ročníkové práce, práce študentskej vedeckej a odbornej činnosti, diplomové práce, záverečné a atestačné práce, dizertácie / Dušan Katuščák. Bratislava: Stimul, 1998
Visualization in scientific computing / Martin Göbel, Heinrich Müller and Bodo Urban (eds.). Wien: Springer, 1995

Spracovanie experimentálnych dát / František Kundracik, Jozef Masarik, Štefan Dubnička. Bratislava: Univerzita Komenského, 1999
Current literature on the state-of-the-art of the topic

Languages necessary to complete the course:
Slovak in combination with English (some of the required literature readings in English)

Notes:

Past grade distribution
Total number of evaluated students: 49

A	B	C	D	E	FX
97,96	2,04	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Martin Gera, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-921/23	Diploma Seminar (2)

Educational activities:
Type of activities: seminar
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual work
Final exam: oral presentation, final evaluation
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Systematic preparation for the defense of the diploma thesis, which will result in improving the student's ability to present the results of his/her work obtained in the preparation of the diploma thesis, increase the students' ability to present, explain and defend their work and its results. Students will learn the basics of the methodology of writing a scientific article in the scope of the diploma thesis.

Class syllabus:
Methodical procedures for elaboration of the structure and time schedule of the diploma thesis; working with professional literature; methods of obtaining data. General principles for writing scientific papers, namely diploma theses.
Graphic design, classification, clear definition of work objectives, correct interpretation of results, correct citations of literature sources.
Written processing of assigned topics according to specific thesis assignments. Examination of the achieved degree of completion of diploma theses and the reality of their successful completion. Discussion of the obtained results.
Seminar presentation of students within the specified time limit with the analysis of the state of the diploma thesis. Joint interactive evaluation of individual performances.

Recommended literature:
Ako písať vysokoškolské a kvalifikačné práce : Ako písať seminárne práce, ročníkové práce, práce študentskej vedeckej a odbornej činnosti, diplomové práce, záverečné a atestačné práce, dizertácie / Dušan Katuščák. Bratislava: Stimul, 1998
Visualization in scientific computing / Martin Göbel, Heinrich Müller and Bodo Urban (eds.). Wien: Springer, 1995

Current literature on the state-of-the-art of the topic related to the diploma thesis

Languages necessary to complete the course:
Slovak in combination with English (some of the required literature readings in English)

Notes:

Past grade distribution
Total number of evaluated students: 17

A	B	C	D	E	FX
88,24	5,88	5,88	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Martin Gera, PhD.

Last change: 30.05.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-912/22	Diploma Thesis (1)

Educational activities:
Type of activities: independent work
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 5

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: check of realization of thesis partial objectives
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Elaboration of diploma thesis. The student acquires skills and knowledge related to the assignment of the diploma thesis, gets acquainted with the methods, procedures and techniques related to the problems of the diploma thesis.

Class syllabus:
The student participates in scientific work related to the assignment of the diploma thesis, performs a research of professional literature, theoretical and experimental tasks related to the problem solution of the diploma thesis, analyzes and processes the results, consults the interpretation of results with the supervisor.

Recommended literature:
Spracovanie experimentálnych dát / František Kundracik, Jozef Masarik, Štefan Dubnička. Bratislava: Univerzita Komenského, 1999
Current literature on the state-of-the-art of the topic

Languages necessary to complete the course:
Slovak in combination with English (some of the required literature readings in English)

Notes:

Past grade distribution
Total number of evaluated students: 47

A	B	C	D	E	FX
87,23	10,64	2,13	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc.

Last change: 15.03.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-913/22	Diploma Thesis (2)

Educational activities:
Type of activities: independent work
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 5

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: check of realization of thesis partial and final objectives
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Further elaboration of the diploma thesis. The student acquires the methods of scientific work, acquires theoretical and experimental skills, acquires skills in the field of analysis and evaluation of results. The student will write a diploma thesis that will meet all the required attributes, and thus creates a prerequisite for the successful completion of the master's degree and the defense of the diploma thesis at the final state exam.

Class syllabus:
The student participates in scientific work related to the assignment of the diploma thesis, performs a research of professional literature, theoretical and experimental tasks related to the problems of the diploma thesis, analyzes and processes the results, consults the interpretation of results with the supervisor. In this phase, he/she confronts his results with theoretical assumptions and other known results in the literature, and to a greater extent he/she devotes to writing a diploma thesis and editing it into a final form.

Recommended literature:
Spracovanie experimentálnych dát / František Kundracik, Jozef Masarik, Štefan Dubnička. Bratislava: Univerzita Komenského, 1999
Spracovanie a vyhodnocovanie meraní / Gejza Wimmer, Rudolf Palenčár, Viktor Witkovský. Bratislava : Veda, 2002
Current literature on the state-of-the-art of the topic

Languages necessary to complete the course:
Slovak in combination with English (some of the required literature readings in English)

Notes:

Past grade distribution Total number of evaluated students: 46					
A	B	C	D	E	FX
84,78	6,52	4,35	4,35	0,0	0,0
Lecturers: prof. RNDr. Zdenko Machala, DrSc.					
Last change: 15.03.2022					
Approved by: prof. RNDr. Zdenko Machala, DrSc.					

STATE EXAM DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-FOZ-991/22	**Course title:** Diploma Thesis Defense
Number of credits: 10	
Educational level: II.	
Course requirements: Final exam: oral Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 0/100	
Learning outcomes: Students will be able to present, defend and discuss the results of their own diploma thesis in the field of environmental physics, renewable energy, meteorology, and climatology.	
Class syllabus: Presentation, defense, and discussion of own results in the field of environmental physics, renewable energy sources, meteorology, and climatology in front of the commission.	
State exam syllabus:	
Languages necessary to complete the course: Slovak in combination with English (some of the suggested literature in English)	
Last change: 11.03.2022	
Approved by: prof. RNDr. Zdenko Machala, DrSc.	

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-111/00	Dynamic Forecasting Methods in Meteorology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites: FMFI.KAFZM/2-FOZ-107/15 - Physics of Lower Atmospheric Layers

Course requirements:
Preliminary evaluation: independent work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
Gain knowledge of methods and procedures for the analysis of processes in the atmosphere using dynamic models. Basic schemes of atmospheric model integration are presented.

Class syllabus:
Assimilation cycle, variational analysis, governed equations of motion, Lagrange's equations of motion of the second kind, Lagrange's formalism, spherical coordinate system, map projections, stereographic projection, generalized vertical coordinate, barotropic atmosphere, outline of equation integration. Energy conservation law for generalized vertical coordinate, available potential energy. Atmospheric oscillations, sound waves, surface and internal gravity waves, orographic waves, mixed inertial and gravity waves, Rossby waves

Recommended literature:
An introduction to dynamic meteorology / James R. Holton. New York : Academic Press, 1992
Příručka dynamické meteorologie / František Pechala, Jan Bednář. Praha : Academia, 1991
Dynamics of the atmosphere: a course in theoretical meteorology / Wilford Zdunkowski and Andreas Bott, Cambridge University Press, Cambridge, 2003. No. of Pages: xviii + 719
Computational Techniques for Fluid Dynamics, Vol. 1: Fundamental and General Techniques / C.A. Fletcher, Springer 2005, 401 pp

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution Total number of evaluated students: 40					
A	B	C	D	E	FX
17,5	17,5	25,0	27,5	10,0	2,5
Lecturers: doc. RNDr. Martin Gera, PhD.					
Last change: 14.03.2022					
Approved by: prof. RNDr. Zdenko Machala, DrSc.					

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-239/22	Ecological Problems of Air Pollution

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: elaboration of a presentation on a selected ecological problem
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 50/50

Learning outcomes:
By completing the course, the student will gain a comprehensive overview of local, regional and global air pollution problems.

Class syllabus:
Influence of the mean residence time of the substance in the atmosphere and exchange times between reservoirs on the spatial impact of the environmental problem. Comprehensive overview of local, regional and global environmental problems. Greenhouse effect, greenhouse gases, efforts to mitigate the anthropogenic contribution to the greenhouse effect. Stratospheric ozone depletion, ozone hole, stratospheric ozone chemistry and legislation. Photochemical smog, chemistry of tropospheric ozone. Acidification and eutrophication of ecosystems. Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP) and related protocols. Current air quality problems in Slovakia. PM particles, emissions from local heating (solid fuel heating) and transport. Smog warning system, information and warning thresholds. Students will choose a specific environmental problem, study it and prepare a presentation.

Recommended literature:
The latest literature, sources from professional and scientific journals and information published on the Internet as recommended by the lecturer at the beginning of the semester
Závodský, D. – Ďurec, F. – Medveď, M., 2001: Atmospheric chemistry and air pollution modelling. UMB Banská Bystrica, 128 pp.
WMO, 2018: Scientific Assessment of Ozone Depletion. Global Ozone Research and Monitoring Project – Report No. 58, 588 pp., Geneva, Switzerland.

Languages necessary to complete the course:

Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 7

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: RNDr. Martin Kremler, PhD., doc. RNDr. Martin Gera, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAI/2-MXX-130/21	Elements of AI

Educational activities:
Type of activities: independent work
Number of hours:
per week: 25 **per level/semester:** 325
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Passing the online course https://course.elementsofai.com/ (in Enlish or Slovak version).

Learning outcomes:
The student will get acquainted with selected basic concepts of artificial intelligence and their use in solving various practical tasks.

Class syllabus:
1. What is artificial intelligence: related areas, AI philosophy.
2. Troubleshooting and UI: Browsing and troubleshooting, browsing and games
3. Probability and chance, Bayes' theorem, naive Bayesian classification.
4. Machine learning: nearest neighbor classifier, regression.
5. Neural networks: basics, creation, modern techniques.
6. Consequences: on predicting the future, the effects of AI on society, summary.

Recommended literature:
Russell S., Norwig P. (2010). Artificial Intelligence: A Modern Approach, (3rd ed.), Prentice Hall. Available in faculty library.
Marsland S. (2015). Machine Learning: An Algorithmic Perspective, (2nd ed.), CRC Press.

Languages necessary to complete the course:
Slovak or English

Notes:
The course consists of 20 numerical and 5 text-based tasks. Numerical tasks are checked automatically, text-based tasks are evaluated anonymously by students.

Past grade distribution
Total number of evaluated students: 95

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Mária Markošová, PhD., prof. Ing. Igor Farkaš, Dr., doc. RNDr. Martin Takáč, PhD.
Last change: 22.08.2021
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAI/2-MXX-130/21	Elements of AI

Educational activities:
Type of activities: independent work
Number of hours:
per week: 25 **per level/semester:** 325
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Passing the online course https://course.elementsofai.com/ (in Enlish or Slovak version).

Learning outcomes:
The student will get acquainted with selected basic concepts of artificial intelligence and their use in solving various practical tasks.

Class syllabus:
1. What is artificial intelligence: related areas, AI philosophy.
2. Troubleshooting and UI: Browsing and troubleshooting, browsing and games
3. Probability and chance, Bayes' theorem, naive Bayesian classification.
4. Machine learning: nearest neighbor classifier, regression.
5. Neural networks: basics, creation, modern techniques.
6. Consequences: on predicting the future, the effects of AI on society, summary.

Recommended literature:
Russell S., Norwig P. (2010). Artificial Intelligence: A Modern Approach, (3rd ed.), Prentice Hall. Available in faculty library.
Marsland S. (2015). Machine Learning: An Algorithmic Perspective, (2nd ed.), CRC Press.

Languages necessary to complete the course:
Slovak or English

Notes:
The course consists of 20 numerical and 5 text-based tasks. Numerical tasks are checked automatically, text-based tasks are evaluated anonymously by students.

Past grade distribution
Total number of evaluated students: 95

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Mária Markošová, PhD.

Last change: 22.08.2021
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-233/13	English Conversation Course (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 3., 7., 9.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
tests, presentations, essays
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Continual improvement of all language skills focused on communication/speaking, listening comprehension and writing. The emphasis is on discourse, lexicology and morphology, word-bank broadening of communicational English as well as English for specific purposes appropriate for university students. This course is a follow up of the previously taught ESP course.

Class syllabus:
This course's focus is to broaden spoken/communicational English for students with B2/C1 level of English knowledge.

Recommended literature:
Appropriate study material is supplied based on the participants'level of English by the lecturer. (Sources- The Guardian, The Herald Morning Sun. The Nine News, The West Australian, BBC News and podcasts, CNN podcasts).

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 318

A	B	C	D	E	FX
77,36	8,81	4,4	1,26	0,94	7,23

Lecturers: Mgr. Aneta Barnes

Last change: 11.04.2024
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-234/13	English Conversation Course (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 4., 8., 10.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
tests, oral presentations, essays
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Continual improvement of all language skills focused on communication/speaking, listening comprehension and writing. The emphasis is on discourse, lexicology and morphology, word-bank broadening of communicational/spoken English as well as English for specific purpose appropriate for university students. This course is a follow up of the Conversational English course 1.

Class syllabus:
This course's focus is to broaden spoken/communicational English for students with B2/C1 level of English knowledge(Upper-Intermediate/Lower Advanced).

Recommended literature:
Appropriate study material is supplied based on the participants'level of English by the lecturer. (Sources- The Guardian, The Herald Morning Sun. The Nine News, The West Australian, BBC News and podcasts, CNN podcasts).

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 201

A	B	C	D	E	FX
82,09	8,96	2,49	1,0	0,0	5,47

Lecturers: Mgr. Aneta Barnes

Last change: 11.04.2024
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-102/10	Environmental Geophysics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: homeworks, test
Final exam: written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Students will understand the principles of selected geophysical methods that are used in monitoring and analyzing the state of the environment. In the presentation of methods, emphasis will be placed on the mathematical and physical principles that make up the essence of these methods (seismic, gravimetric, electrical, magnetic, and electromagnetic sounding methods).

Class syllabus:
Tectonic earthquakes, origin of tectonic earthquakes. The basics of the theory of elastic waves, types of seismic waves. Macroseismic intensity. Macroseismic scales. Energy and earthquake size. Magnitude, types of magnitude. Magnitude saturation. Seismograms. Wave content of seismograms for near earthquakes. Earthquake detection. Location of earthquakes. Earthquake activity of the territory of Slovakia. Methods of seismic hazard analysis. Seismic hazard of the territory of Slovakia.
Gravimetry. Gravity anomalies and estimation of rock densities from gravity measurements. Magnetometry. Earth magnetic field - its structure and variations. Magnetic properties of rock samples. Magnetometers. Terrestrial and areal measurements of magnetic field. Geoelectrical methods. Resistivity profiling. Electrochemical methods, method of spontaneous and induced polarisation. Electromagnetic sounding, magnetotelluric methods. Electromagnetic smog.

Recommended literature:
J. Gruntorád a kol.: Principy metod užité geofyziky, Státní nakladatelství technické literatury (1985);
W.M. Telford et al. Applied geophysics. Cambridge University Press. (1990)
L. Reiter: Earthquake hazard analysis. Issues and insights, Columbia University Press (1990)
P. Shearer: Introduction to seismology, Cambridge University Press (1999)

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 32

A	B	C	D	E	FX
59,38	21,88	12,5	6,25	0,0	0,0

Lecturers: prof. RNDr. Roman Pašteka, PhD., RNDr. Róbert Kysel, PhD.

Last change: 12.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-101/10	Environmental Physics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Exam: written and oral exam, successful completion of the written part is condition of the oral part.
Share in overall rating: 80/20.
Indicative rating scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
After completing the course, students will gain basic information about the current status of the field of environmental physics.

Class syllabus:
Principles of heat conduction and heat conduction equation, heat waves, sudden temperature change, stationary heat conduction in a cylinder and ball plate, without internal heat sources, efficiency of real and ideal heat machines, efficiency of combined cycle systems. Nuclear reactions, nuclear excitation energy, fission mechanism, neutron diffusion, neutron absorption and moderation, reactor. Synthesis and energy, Sulfur pollutants in the environment (modelling of the spread of substances, area continuous source, radon and stability). Environmental compartments and their interaction, Composition and physical properties of the ocean, Vertical stability of the ocean and atmosphere, Transport: Definitions, Transport processes, Advection and diffusion effects, Diffusion of tracers, Fluids in the environment, Mechanical properties of fluids and solids, Lagrange vs. Euler representation, Continuity equation, Equation of motion in fluid dynamics, Forces in fluid media: - Gravity and geopotential, Equation of motion I: Euler, Friction, Geophysical dynamics of fluids: Centrifugal and Coriolis force, Equation of motion II: Navier-Stokes equation, components of Navier-Stokes equation, Analysis of Navier-Stokes equation, Order sizes of parts of Navier-Stokes equation, Concept of vorticity, Unstable solutions of differential equations, Turbulence criteria: Reynolds number, Turbulence and Reynolds number.

Recommended literature:
Principles of environmental physics / John Monteith, Mike Unsworth. Burlington : Academic press, 2008
Climates of the Oceans / H. Van Loon. Amsterdam : Elsevier, 1984

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 56

A	B	C	D	E	FX
48,21	30,36	10,71	8,93	1,79	0,0

Lecturers: doc. RNDr. Ivan Sýkora, PhD., doc. RNDr. Radoslav Böhm, PhD.

Last change: 16.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

STATE EXAM DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KJFB/2-FOZ-954/22	**Course title:** Environmental Physics and Renewable Energy Sources
Number of credits: 6	
Educational level: II.	

Course requirements:
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
The student consolidates the knowledge and skills acquired during his/her master's study and will understand their interrelationships and the context. He/she will pass the state exam in environmental physics and renewable energy sources.

Class syllabus:
The syllabi of the exam, which are published in advance, are based on the content of compulsory and optional subjects of block A, but are not strictly linked to them.

State exam syllabus:
Block 1 Compulsory subjects - the student randomly chooses 1 question
Environmental physics:
1. Heat engines (maximum efficiency of heat engines, efficiency of real heat engines, efficiency of combined cycle systems)
2. Synthesis (Lawson's criterion)
3. Fission (principle, diffusion, absorption, neutron production, reactor equation, multiplicative factor k)
4. First and second Fick's law, diffusion coefficient and concentration distribution variance
5. Lagrange and Euler representations within continuum mechanics. What they express and how they differ.
6. Navier-Stokes equation, behavior characteristics of the solutions of Navier-Stokes equation
Methods of Data Set Analysis:
7. Binomial, Poisson and normal distributions.
8. Chi square distribution, Student distribution, Fischer distribution.
9. Uncertainties of measurements and their propagation (why there are Gaussian uncertainties, CLT, weighted average, combinations of uncertainties, relative uncertainties, systematic and random uncertainties).
10. Estimates - definition of an estimator, requirements for a good estimator, the principle of the maximum likelihood method and the principle of the least squares method.
11. Hypothesis testing (characteristics, type I and II errors, strength and significance of the test, chi square test, run test (sign test)
Spread of pollutants in the environment:
12. Pollutants in the environment, emissions and immissions, vertical temperature stability and conditions for the dispersion of pollutants in the air.

13. Mean residence time of substances in the atmosphere, exchange times. Categories of environmental problems: local, regional and global.
14. Atmospheric aerosol, PM particles, benzo(a)pyrene, local heating and transport.
15. Long-distance transmission of pollutants in Europe, acid rains, photochemical smog.
16. Stratospheric ozone, occurrence of ozone holes, legislation on protection of stratospheric ozone layer.
17. Greenhouse effect of the atmosphere, greenhouse gases, GWP, legislation.
18. The cycle of substances on Earth, propagation of pollutants in water.
==========

Block 2 - Compulsory elective courses A - Energy sources - the student randomly chooses 1 question
Combustion and thermochemical processes
1. Origin and fundamental properties of fossil fuels (oil, natural gas, coal)
2. Unconventional types of oil and gas (tar sands, shale oil, tight oil, shale gas, tight gas, coal bed methane)
3. Energy recovery of coal (combustion, gasification, liquefaction, carbonisation)
4. Less valuable and alternative fuels (ethanol, methanol, dimethyl ether, biodiesel, biogas, landfill gas)
5. Spark-ignition and compression-ignition internal combustion engine (operation phases of 2- and 4-stroke internal combustion engine, methods of preparation and principle of ignition of the ignition mixture, predominant type of flame)
6. Stoichiometry, thermodynamics and kinetics of chemical reactions in the combustion process
7. Types of flames - diffusion and premixed, vaporization of droplets and their combustion, kinetic and diffusion combustion, combustion of solid fuels, smouldering, explosion, detonation.
8. Formation of combustion product emissions (NOx, COx, CHx, VOC, particulates).
9. Thermochemical processes (gasification, pyrolysis, liquefaction) and their use in waste management.
Solar energy and photovoltaics
8. Solar spectrum (energy flux density, atmospheric and latitude effects)
9. Photovoltaic electricity source (components of the PV system and their functions)
10. Volt-ampere characteristics of the solar cell (VOC, ISC, Vmp, Imp values), filling factor (definition and its use, point of maximum power)
11. Dependence of the volt-ampere characteristic of the solar cell on the temperature (connection with Eg (T))
12. Solar cell efficiency (losses affecting efficiency, optimal solar cell)
13. Structure of the solar cell (pn-junction, description of components and function of individual layers)
14. Division of solar cells (silicon technology, volumetric, thin-film, use of nanostructures)
Nuclear energy and environment
15. Nuclear reactor classification. Generation IV nuclear reactors.
16. Fuel cycle. Effect of radiation on corrosion.
17. Radiation sources and their shielding. Shielding of nuclear sources.
18. Nuclear safety. Concept of protection in depth.
19. Radioactive waste separation, treatment and disposal.
20. Radionuclide dispersion models.
21. Monitoring of radioactivity in the atmosphere and the Earth's crust.
Hydrogen power and thermonuclear fusion
26. Physical and chemical properties of hydrogen, occurrence of hydrogen in nature, areas of hydrogen utilization, hydrogen as an energy carrier.

27. Hydrogen production by various methods. Thermochemical production, Water electrolysis: thermodynamics and process efficiency, types of electrolyzers. Production of hydrogen from methane and hydrocarbons by pyrolysis with steam reforming. Biological systems of hydrogen production. Hydrogen production from ammonia.
28. Use of hydrogen in industry as a reducing agent, fuel cells and other energy uses of hydrogen. Overview of fuel cell types and examples of their use.
29. Hydrogen storage: liquefaction, adsorption and absorption in carbon systems (fullerenes, nanotubes, iC structures), metalhydrides, powerballs (magnesium, ceramic, glass and others), storage in chemical compounds (hydrazine and its compounds).
30. Energy utilization of thermonuclear fusion, the most important reactions, conditions for achieving energy gain. Basic types of thermonuclear reactors, plasma heating methods.
==========

Block 3 - Compulsory elective courses A - Radiation physics - the student randomly chooses 1 question
Isotope methods in environmental physics
1. Physical-chemical basis of isotope fractionation, isotope delta notation.
2. Application of stable isotopes in hydrology and carbon cycle study in nature.
3. Cosmogenic radionuclides and their applications in environmental studies.
4. Radon in the environment and its use for the study of natural processes.
5. Radionuclide dating methods (Rb-Sr, K-Ar, Sm-Nd, U-Pb, ..).
Radiation environmental physics
6. Classification of sources of radioactivity in the environment. Significant natural radionuclides.
7. Time series, distribution, migration and transport of primordial radionuclides.
8. Equation of accumulation of short-lived 222-Rn decay products. Latent energy concentration of radon decay products, equilibrium factor.
9. Radiotoxicity. Ecologically important radionuclides. Exposure from natural radionuclides, calculation of effective doses.
10. Radiation regulation for exposure from radon and other natural radionuclides.11. Nuclear-analytical methods for monitoring environmental contamination.
Radionuclide monitoring methods
12. Energy resolution of the detector, Fano factor.
13. Interaction of charged particles with the material environment
14. Interaction of gamma radiation with the material environment
15. Scintillation spectrometry using liquid scintillators (components of liquid scintillator, causes of reduction of detection efficiency of liquid scintillator (so-called quenching)
16. Gamma spectrometry (electronic path of a semiconductor spectrometer, procedure for processing a simple instrument gamma spectrum, spectrum purity, peak / Compton ratio)
17. Scintillation and semiconductor detectors.
18. Criteria for selection of methods for measuring volume activity, environmental sampling.
19. Minimum measurable activity, how to express and influence it?
20. Gas radiation detectors and specifics of alpha and beta radiation measurements.
==========

Block 4 - Compulsory elective courses A - Environmental physics and technology - the student randomly chooses 1 question
Air Pollution Control Technologies
1. Technologies for pollutant prevention: chemical, physical and biological methods.
2. NOx/SOx reduction: adsorption, absorption, selective catalytic reduction.

3. CO2 reduction: capture and separation, sequestration in deep seas, extracted salt, oil and gas deposits, production and storage of CO2 clathrates, utilization of CO2, biochar, artificial weathering.
4. O3 reduction: adsorption, thermal and catalytic decomposition.
5. Hydrocarbon reduction: biofiltration, condensation, adsorption, thermal and catalytic oxidation, steam and dry reforming.
6. Particulate matter (PM) reduction: gravity settling chambers, cyclones, wet scrubbers, fabric filters, electrostatic precipitators.
7. Mobile sources of pollution: parameters influencing emissions, performance and fuel consumption. Three-way and oxidation catalysts and diesel particulate filter, NOx reduction (AdBlue).
8. Removal of pollutants by electric discharges and plasma, and catalyst systems.
Water Pollution Control
9. Drinking, utility and operating water and wastewater - characteristics and basic properties.
10. Overview of water and soil pollutants, their effects on the environment, organisms and humans.
11. Main sources of water and soil pollution.
12. Mechanical and biological processes for water purification and treatment.
12. Physical and chemical processes for water purification and treatment.
14. Advanced oxidation processes for water purification and treatment.
15. Wastewater treatment plants, commercial and industrial facilities - drinking and utility water.
16. Chemical and biological analysis of water.
Solid Waste Treatment
17. Characteristics of waste. Its composition, quantity, distribution and calorific value.
18. Waste prevention and reduction. Reduction of waste sources.
19. Waste recycling: aluminum, paper, plastics, glass, metals. Energy recovery. Waste collection, separation and treatment. OLO and ASA.
20. Incineration, gasification and pyrolysis of waste. Plasma waste disposal methods. Thermal plasma, transmitted and non-transmitted arc. Industrial installations.
21. Composting: types of compost, factors influencing compost quality, composting methods and compost use.
22. Landfilling: landfill classes, landfill gases and leachate, waste solidification, landfill operation, closure and reclamation. Waste legislation.

Recommended literature:
Detailed lists of literature are in the information sheets of individual subjects

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested literature in English)

Last change: 23.03.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-279/23	Exercises to Complex Solutions of Environmental Problems

Educational activities:
Type of activities: practicals
Number of hours:
per week: 1 **per level/semester:** 13
Form of the course: on-site learning

Number of credits: 1

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Final exam: practical
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): Scale of assessment (preliminary/final): 100/0

Learning outcomes:
The student will practically strengthen the acquired basic knowledge and an overview of environmental management and the field of various pollutants and their effects, as well as the basics of environmental toxicology, including the most important laws in environmental and energy legislation, an overview of the best available technologies in all areas of the environment (air, water, waste , greenhouse compounds, soil pollution) and will be confirmed in a comprehensive overview of global and local environmental problems. During the semester, the student will practice the measurement of atmospheric aerosols and will process a selected relevant topic and present his solution to an environmental problem.

Class syllabus:
Practical examples of environmental management, pollution control vs. environmental management, environmental audit, global and local environmental problem and comprehensive insight into its solutions, e.g. compares the carbon footprints of various processes and proposes complex and unconventional solutions. In doing so, he uses the acquired overview of atmospheric, water and soil pollutants and their effects on the environment, living organisms and people, selected environmental and energy laws and the main pillars of European environmental and energy policy and the possibilities of their implementation in practical economic life. Emphasis on the importance of atmospheric aerosols regarding global and local environmental problems and practical exercises in their measurement.

Recommended literature:
B. Smit, J.A. Reimer, C.M. Oldenburg, I.C. Bourg: Introduction to Carbon Capture and Sequestration, Imperial College press 2014
J.H. Seinfeld, S.N. Pandis: Atospheric Chemistry and Physics – from Air pollution to climate change, Wiley 2016

Topical presentations of students of previous years

Languages necessary to complete the course:
English

Notes:
course will be included into international university alliance ENLIGHT

Past grade distribution
Total number of evaluated students: 10

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc.

Last change: 30.05.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-141/00	French Language (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
French language is taught at two levels: beginner and intermediate. Students opt for one of them depending on whether they wish to obtain the fundamentals of the language or wish to maintain and/or improve previous knowledge of French.

Recommended literature:
Capelle Guy, Menand Robert: Le Nouveau taxi 1, Hachette FLE Paris, France 2009, ISBN 978-2-01-155548 - 9

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 499

A	B	C	D	E	FX
48,5	19,44	16,63	7,82	2,0	5,61

Lecturers: Mgr. Ľubomíra Kožehubová

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-142/00	French Language (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
The subject continues the program of French language (1) and provides courses of essential and intermediate French language.

Recommended literature:
Capelle Guy, Menand Robert: Le Nouveau taxi 1, Hachette FLE Paris, France 2009, ISBN 978-2-01-155548 - 9

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 307

A	B	C	D	E	FX
45,6	22,48	16,94	8,79	2,28	3,91

Lecturers: Mgr. Ľubomíra Kožehubová

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-241/00	French Language (3)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3., 9.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
The subject provides a course of intermediate French language, covering not only general, but also technical language.

Recommended literature:
Capelle Guy, Menand Robert: Le Nouveau taxi 1, Hachette FLE Paris, France 2009, ISBN 978-2-01-155548 - 9

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 128

A	B	C	D	E	FX
48,44	24,22	17,19	5,47	0,78	3,91

Lecturers: Mgr. Ľubomíra Kožehubová

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-242/00	French Language (4)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4., 10.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
The subject provides a course of intermediate French covering not only general, but also technical French language.

Recommended literature:
Menand Robert: Le Nouveau taxi 2, Hachette FLE, Paris, France 2009, ISBN 978-2-01-155551 - 9

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 79

A	B	C	D	E	FX
43,04	32,91	16,46	2,53	1,27	3,8

Lecturers: Mgr. Ľubomíra Kožehubová

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-215/22	Gas Discharges and their Applications

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Antirequisites: FMFI.KAFZM/1-OZE-272/15

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
By completing the course, the student will gain knowledge of the physics of electric discharges and plasmas and its applications in various fields.

Class syllabus:
Basic characteristics of plasma. Methods of plasma generation. Advantages of using electric discharges for plasma generation. Overview of the basic types of discharges (glow, corona, arc, spark, dielectric barrier discharge). Formation of discharges: statistical theory of electric discharges, statistical model of electron avalanche, statistical model of ignition of electric discharges at low pressures. Discharge formation at higher pressures: streamer description. Gas breakdown at higher pressures, plasma transition from low to high ionization. Discharges in contact with and in water. Environmental applications - air purification (gases and particulates), water and waste disposal. Biological and medical applications - bio-decontamination and sterilisation, tissue and surface treatment, wound healing, cancer treatment and other therapies. Agricultural applications - seed germination, plant growth, nitrogen fixation and fertiliser treatment. Energy applications - fuel reforming and hydrogen generation, plasma assisted combustion and ignition, electromagnetic shielding, thermonuclear fusion. Materials applications - welding, cutting, etching, deposition and implantation. Optical applications - radiation sources, plasma displays, xerox, lasers, gas analysers.

Recommended literature:
V. Martišovitš: Základy fyziky plazmy, Bratislava (2006)
Y. Raizer: Gas discharges, Springer (1991)
P. K. Chu and X. P. Lu: Low temperature plasma technology, CRC Press (2014)

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 8

A	B	C	D	E	FX
50,0	50,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Mário Janda, PhD., prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Karol Hensel, PhD.

Last change: 08.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-109/22	General Climatology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: -
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By completing the course, the student will gain a comprehensive knowledge of the theory and the physics of the global climate system and the theory of formation and development of specific climatic patterns in the individual Earth's regions

Class syllabus:
Earth's global climate system, climate forming factors and processes and their interactions. Sources utilized in climatology. Radiative and circulation climate forming factors. Climatic patterns for selected climatic elements. Climate and its peculiarities in the individual Earth's regions. Dynamic climatology. Climate changes and variability. Climate changes in the geological and historical past of the Earth. Anthropogenic impacts on climate. Climate modeling. Climatic scenarios for the 21st century. Climate change impacts.

Recommended literature:
Bluthgen, J., Weischet, W.: Algemeine Klimageographie, 3.Ed., Walt de Gruyter, Berlin 1980, 882 pp.
Chrgian, A.Ch.: Fizika atmosfery, Tom 1 a 2., Gidrometeoizdat, Leningrad 1978, 247 a 319 pp.
Okolowicz, W.: General Climatology Polish Sci.Pub., Warszawa 1976, 422 pp.
Netopil, R. et al.: Fyzická geografie 1. SPN, Praha 1984, 272 pp.
Peixoto, J.P., Oort, A.H.: Physics of Climate. AIP Press, Springer, New York 1992, 520 pp.;
Lapin, M., Tomlain, J.: Všeobecná a regionálna klimatológia. Vyd. UK Bratislava, Bratislava 2001, 184 pp.;
Pedlosky, J.: Ocean Circulation Theory. Springer, Berlin 1998, 455 pp.;
Dobrovolski, S.G.: Stochastic Climate Theory. Springer, Berlin 2000, 282 pp.

The newest information from the INTERNET-u and journals.

Languages necessary to complete the course:
Slovak in combination with English.

Notes:

Past grade distribution
Total number of evaluated students: 71

A	B	C	D	E	FX
46,48	30,99	21,13	0,0	1,41	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Marián Melo, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-305/22	Geothermal Energy

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: test
Indicative evaluation scale: A 91%, B 81%, C 71%, D 61%, E 51%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
The student will acquire basic knowledge of the genesis, occurrence and use of geothermal energy sources. The expression of temperature, gas and mineralisation effects on the measured mass and hydrostatic pressure of geothermal energy sources shall be noted. It will be able to characterise the technological characteristics of geothermal energy sources and how they are disposed of after heat recovery. It will have an overview of the hydrogeothermal characteristics of the Western Carpathians and the way geothermal energy is used in Slovakia and the world. Acquire the skills necessary for the assessment of the heat island under the city and the use of heat pumps for urban buildings.

Class syllabus:
Geothermal energy sources, their connection to different types of geological environment and prospecting. Geothermal fields and hydrogeothermal structures. Geothermal and its methods in geothermal research. Geothermal wells — drilling, building and testing technologies. Evaluation of hydrodynamic tests carried out on geothermal wells. Assessment of the thermal energy potential of geothermal sources. Processes for the formation of the chemical composition of geothermal waters, their technological properties and their disposal. Hydrogeothermal characteristics of Western Carpathians. Use of geothermal energy resources in Slovakia and worldwide. Assessment of the state of geothermal groundwater bodies in Slovakia. Heat distribution in shallow alluvial quaternary horizons and assessment of their energy potential in the territory of Slovakia. A thermal island beneath the cities. Hydrogeological survey for water-to-water heat pumps. Legislation.

Recommended literature:
Fendek, M. et al. 1999: Geotermálna energia. Učebné texty PriF UK, Bratislava; Franko, O., Remšík, A., Fendek, M. eds. 1995: Atlas geotermálnej energie Slovenska / Atlas of Geothermal

Energy of Slovakia. Bratislava, Geologický ústav Dionýza Štúra; Bodis, D., Remsik, A., Cernak, R., Marcin, D., Zenisova, Z., Flakova, R., 2017: Geothermal and hydrogeological conditions, geochemical properties and uses of geothermal waters of the Slovakia. In: Geothermal Water Management. London, CRC Press. Krčmář, D. et al. 2019: Výskyt, pohyb a využitie tepla plytkých zvodnených kolektorov. Banská Bystrica : Slovenská asociácia hydrogeológov, 81 s. Marcin, D. et al. 2020: Hodnotenie stavu geotermálnych útvarov podzemných vôd na území Slovenskej republiky. Geologická štúdia. Štátny geologický ústav Dionýza Štúra, Bratislava. 295 s., 22 príloh.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 8

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Dávid Krčmář, PhD., Mgr. Daniel Marcin, Ph.D., doc. RNDr. Renáta Fľaková, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-151/00	German Language (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
To master the fundamentals of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency)

Class syllabus:
German language is taught at three levels: beginner, intermediate and advanced. Students opt for one of them depending on whether they need to learn the fundamentals or maintain and/or improve their previous knowledge.
This course's focus is to master the fundamentals of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency)

Recommended literature:
Appropriate study material is supplied by teacher based on the participants'level of German proficiency.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 874

A	B	C	D	E	FX
38,33	24,71	18,42	8,81	2,86	6,86

Lecturers: Mgr. Alexandra Maďarová, Mgr. Simona Dobiašová, PhD.

Last change: 05.09.2025

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-152/00	German Language (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
To master the fundamentals of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency)

Class syllabus:
German language is taught at two levels: beginner and intermediate. Students opt for one of them depending on whether they wish to obtain the fundamentals of the language or wish to maintain and/or improve previous knowledge of German.
This course’s focus is to to master the fundamentals of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency)

Recommended literature:
Appropriate study material is supplied by teacher based on the participants’level of German proficiency

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 542

A	B	C	D	E	FX
38,01	19,56	19,56	12,36	3,51	7,01

Lecturers: Mgr. Alexandra Maďarová, Mgr. Simona Dobiašová, PhD.

Last change: 05.09.2025

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-251/00	German Language (3)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3., 9.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Master the basics of general language and basic professional terminology of individual fields of study (depending on the advanced level of students)

Class syllabus:
The course is a follow-up to the German language (1,2). The subject provides a course of intermediate or advanced German language.
This course's focus is to deepen the knowledge of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency).

Recommended literature:
Appropriate study material is supplied by teacher based on the participants'level of German proficiency.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 191

A	B	C	D	E	FX
45,03	23,04	19,37	6,81	2,09	3,66

Lecturers: Mgr. Alexandra Maďarová, Mgr. Simona Dobiašová, PhD.

Last change: 05.09.2025

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-252/00	German Language (4)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4., 10.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Master the basics of general language and basic professional terminology of individual fields of study (depending on the advanced level of students)

Class syllabus:
The course is a follow-up to the German language (1-3). It provides a course of intermediate and advanced German language.
This course's focus is to deepen the knowledge of the common language and basic technical terms of particular fields of study (depending on the student's level of German proficiency).

Recommended literature:
Appropriate study material is supplied by teacher based on the participants'level of German proficiency.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 104

A	B	C	D	E	FX
44,23	22,12	14,42	10,58	3,85	4,81

Lecturers: Mgr. Alexandra Maďarová, Mgr. Simona Dobiašová, PhD.

Last change: 05.09.2025

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-155/22	Hydrogen Energy and Thermonuclear Fusion

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Final exam: written and oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
The student will gain an overview of the physical principles, methods and technological possibilities of use hydrogen for energy production as well as energy storage. He will understand the possibilities as well constraints arising from the use of hydrogen as an energy carrier in the context of requirements sustainable energy. By completing the course, the student will also gain a basic overview of the issue energy recovery of a controlled thermonuclear reaction.

Class syllabus:
Hydrogen as an energy carrier, physical properties of hydrogen, safety of working with hydrogen. Production hydrogen by electrolysis of water, thermodynamics of electrolysis, different types of electrolysers (alkaline, PEM, high temperature), directions and perspectives of development. Hydrogen transport. Hydrogen storage in the form of compressed gas, compatibility with materials. Cryogenic storage liquefaction, metal hydrides and sorbents. Production of synthetic fuels (methane, methanol, ammonia and other). Hydrogen energy utilization, fuel cells (PEM, alkaline and others), flame combustion, catalytic combustion, combustion in gas turbines and internal combustion engines. Use of hydrogen in transportation, residential applications and other areas. Energy use of nuclear fusion. Reactions and their effective cross sections, the need for high-temperature plasma. Ignition temperature, Lawnson's criterion, approaches to plasma retention. Basic types of reactors, plasma heating methods. Current state of development.

Recommended literature:
Balajka J.: Vodík a iné nové nosiče energie, Alfa, Bratislava, 1982.
M.F.Hordeski: Alternative fuels-The future of hydrogen, CRC Press, London, 2006.
Andreas Zuttel, Andreas Borgschulte, Louis Schlapbach: Hydrogen as a future energy carrier, Willey-VCH, 2008.

A. Godula-Jopek, ed., Hydrogen production by electrolysis, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2015.
A. A. Harms, K. F. Schoepf, G. H. Miley, D. R. Kingdon: Principles of fusion energy, World Scientific Publishing, 2000.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 15

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Marcela Morvová, PhD., Mgr. Michal Stano, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI-PriF.KMPLG/2-FOZ-301/22	Impact of Mining on the Environment

Educational activities:
Type of activities: seminar
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 91%, B 81%, C 71%, D 61%, E 51%

Learning outcomes:
Ability to principally assess the impact of mining activities and mineral processing on the environment and characterize the causes and possibilities of risk prevention (eg acidification of the environment and mobilization of metals, cyanide technology), knowledge of basic procedures for reclamation of mining areas and waste recovery as secondary raw materials. Knowledge of basic enviro-legislation and valid enviro-policies of the state and the EU.

Class syllabus:
The relationship between the consumption of mineral resources (MR) and the existence of human society, sustainable development and extraction of raw materials. Classification of deposits in terms of environmental risk. Negative impacts of MR mining on the environment and their regulation - examples from Slovakia (local impacts, legislation). Negative impact prevention and basic reclamation procedures. Utilization of mining waste as a secondary raw material. Global aspects: Environmental impacts of coal and hydrocarbon (fossil fuels) mining and exploitation. Some problems associated with the extraction of industrial minerals. Processes in metal sulphide deposits: oxidation of pyrite, acid mine drainage formation, acid mine water neutralization and secondary minerals formation. Mineral research methods Mining water treatment and disposal: active and passive systems. Metal mobility in a mining environment. Risks and potential of abandoned antimony deposits in Slovakia. Cyanides in mining waste. Current projects - monitoring and risk assessment of mining, legislative activities, comprehensive solutions.

Recommended literature:
O. Lintnerová 2002: Vplyv ťažby nerastných surovín na životné prostredie. UK, Bratislava 1-160. Lintnerová et al., 2010: Environmentálne riziká tvorby kyslých banských vôd na opustenom ložisku Smolní. UK Bratislava,1-157. Jambor L.J., Blowes D.W., Eds., 1994 Short

course handbook on environmental geochemistry of sulfide mine-wastes. Min. Assoc. Canada, 22. Internal textbook. Šottník et al., 2015: Environmentálne záťaže, SAŽP Banská Bystrica.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 0

A	B	C	D	E	FX
0,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. Mgr. Peter Šottník, PhD.

Last change: 16.09.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.CENAM/2-MXX-134/26	Innovation and Entrepreneurship in Natural and Technical Sciences

Educational activities:
Type of activities: lecture / independent work
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Type, volume, methods and workload of the student - additional information
2/1 (lecture / individual work)

Number of credits: 3

Recommended semester: 1., 7.

Educational level: I.II., II.

Prerequisites:

Course requirements:
The condition for admission to the exam is active participation in at least 80% of the lessons.
The final assessment consists of a presentation of the semester project. To successfully complete the course, it is necessary to achieve at least 50% of the overall score.
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
After completing the course, students can describe the possibilities for commercialization of scientific and technological research. They can identify market needs, assess the market potential of a technological solution, and are familiar with the terminology of entrepreneurship, technology transfer, and intellectual property protection. They understand the overall structure of a business plan and the main forms of financing for technological projects. They are familiar with the principles of communication, teamwork, and team leadership and can apply them appropriately in project work and its presentation.

Class syllabus:
1. Commercialization of scientific research.
2. Fundamentals of entrepreneurship and startup terminology.
3. Identification of problems and customer needs analysis (design thinking).
4. Technology transfer. Technology Readiness Levels (TRL).
5. Intellectual property and its protection.
6. Market, customer, and market potential of a technological solution.
7. Business Model Canvas. Revenue models.
8. Sources of financing for technological projects.
9. Pitching and communication of the solution.
10. Fundamentals of management and leadership.
11. Innovation support and incubation structures at national and international levels.

Recommended literature:
Clark, Timothy R., et al. Business Model Generation. Wiley, 2010

Languages necessary to complete the course:
Slovak

Notes:

Past grade distribution
Total number of evaluated students: 0

A	B	C	D	E	FX
0,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Tomáš Plecenik, PhD., Mgr. Veronika Hidaši Turiničová, PhD.

Last change: 13.03.2026

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KDMFI+KAI/2-MXX-131/21	International Team-based Research Project

Educational activities:
Type of activities: course / independent work
Number of hours:
per week: 3 **per level/semester:** 39 / 30s
Form of the course: on-site learning

Number of credits: 5

Recommended semester: 1., 7.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Continuous assessment: active participation in research in an international student team (25%), presentation of work in a workshop (25%), scientific article (50%)
Indicative evaluation scale: A 90 %, B 80 %, C 70 %, D 60 %, E 50 %
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Students will learn in the team to agree on a common research topic, formulate research questions, determine research methods for the problem, collect and evaluate data, discuss their findings, present research results to the professional public, analyze and evaluate the scientific work of their colleagues, prepare a scientific article suitable for publication

Class syllabus:
- Research methodology
- Design and implementation of a research project in an international group (preferably interdisciplinary)
- Methods and tools for collaboration in virtual space, collaboration in science and practice
- Academic writing, presentation of research results through scientific articles; objectives, content and structure of scientific articles; forms of academic publication, publication forums and evaluation of their quality
- Quality assurance and feedback - peer review
- Communication of results through posters or conference presentations

Recommended literature:
- Teachers' own electronic study materials published on the course website or in the Moodle system
- Gavora, Peter a kol. 2010. Elektronická učebnica pedagogického výskumu. [online]. Bratislava : Univerzita Komenského, 2010. Dostupné na: http://www.e-metodologia.fedu.uniba.sk/ ISBN 978–80–223–2951–4.

- Tharenou, P., Donohue, R. and Cooper, B., 2007. Management research methods. Cambridge University Press.
- Topping, A., 2015: The Quantitative-Qualitative Continium. In: Gerrish, K. and Lathlean, J., The Research Process in Nursing, p. 159-172
- Williamson, K. and Johanson, G. eds., 2017. Research methods: Information, systems, and contexts. Chandos Publishing.

Languages necessary to complete the course:
English

Notes:

Past grade distribution
Total number of evaluated students: 10

A	B	C	D	E	FX
70,0	0,0	0,0	0,0	30,0	0,0

Lecturers: prof. RNDr. Zuzana Kubincová, PhD., doc. RNDr. Martin Homola, PhD.

Last change: 22.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-203/10	Isotope Methods in Environmental Physics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
A student can earn 30% per semester for the course project and its presentation, and the final written exam is weighted at 70%. A student must earn at least half of the points for the project to pass the final written examination. The student must also score at least 36 points on the final written examination.
Grades: A (100-91), B (90-81), C (80-71), D (70-61), E (60-51), FX (50-0).
Mid-term / final assessment weighting: 30% mid-term assessment (project + presentation) / 70% final written exam.
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
By completing the course, the student will gain a comprehensive knowledge of the applications of stable and radioactive isotopes in the monitoring and study of environmental processes.

Class syllabus:
Stable isotopes: 1. Properties of ecologically significant stable isotopes. 2. Physico-chemical basis of isotope fractionation. Isotope delta notation. 3. Stable isotopes of hydrogen, carbon and oxygen. Meteoric water line. 4. Isotope fractionation in open and closed systems. 5. Use of isotopes as tracers of pollution, species migration and in medicine. 6.The role of isotopes in the observation of global climate change.
Radioactive isotopes: 7. Physical basis of radionuclide applications. 8. Origin and properties of environmentally important radionuclides. 9. Radionuclides as tracers of atmospheric processes. 10. Use of radionuclides in hydrology and geology. 11. Radionuclide dating. 12. Methods of measurement of stable and radioactive isotopes. 13. International isotope standards.

Recommended literature:
B. Fry: Stable Isotope Ecology. Springer Science, (2006), 308 p.
R. E. Criss: Principles of Stable Isotope Distribution. Oxford Univesity Press, (1999), 254 p.
Mook W. G.: Isotopes in the Hydrological Cycle, IAEA Vienna, 2000
Froehlich K. (editor): Environmental Radionuclides: Tracers and Timers of Terrestrial Processes, Elsevier, 2010

Baskaran M.: Radon: A Tracer for Geological, Geophysical and Geochemical Studies, Springer, 2016

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 31

A	B	C	D	E	FX
41,94	12,9	22,58	9,68	12,9	0,0

Lecturers: RNDr. Martin Bulko, PhD., doc. RNDr. Monika Müllerová, PhD., Ing. Jakub Kaizer, PhD.

Last change: 22.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KEF+KAFZM/2-FOL-237/15	Laser Applications, Processes and Diagnostics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Antirequisites: FMFI.KEF/2-FOL-237/09

Course requirements:
Continuous assessment: test
Exam: oral
Indicative assessment scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 40/60

Learning outcomes:
After completing the lecture, the student should be acquainted with
issues of the latest trends in laser-assisted production and modification of materials.

Class syllabus:
Use of lasers for surface analysis.
Laser ablation in combination with inductively coupled palms (LA ICP MS, LA ICP OES).
Laser-induced spark spectroscopy and its use.
Micro-Raman spectroscopy (composition determination, surface determination
temperatures from the ratios of Stokes and anti-Stokes spectra).
Use of lasers for surface treatment (etching, PLD deposition). Use of lasers in metallurgy.
Thermal, photophysical and photochemical processes. Reaction kinetics and particle transport. Atomization and formation of clusters.
Surface melting processes. Material evaporation and plasma formation processes. Material deposition. Transformation and synthesis
material, creation of structures. Measurement and diagnostic techniques.

Recommended literature:
Laser spectroscopy : Basic concepts and instrumentation / Wolfgang Demtröder. Berlin : Springer, 1981
Svetlo : Vlny, lúče, fotóny / Anton Štrba, Vladimír Mesároš, Dagmar Senderáková. Nitra : Enigma, 2011
Selection of current articles from the area.

Languages necessary to complete the course:
english

Notes:

Past grade distribution
Total number of evaluated students: 9

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Pavel Veis, CSc., doc. RNDr. Mário Janda, PhD., M.Sc. Sahithya Atikukke, PhD.

Last change: 17.02.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KEF/2-FTL-114/22	Measurement Methods in Solid State Physics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
The evaluation of the course has a form of an oral exam, grading of which reflects the overall orientation of the student in the covered topics. Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%.
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By completing the course, students will gain an overview of selected electrical, magnetic and optical measurement methods used for characterization of properties of solids.

Class syllabus:
Conductivity and contact phenomena. DC methods of measuring resistance and conductivity - probe methods, Van der Pauw method. Arrhenius plot – determination of activation energies. Measurement of very small currents and voltages. Hall effect. AC measurements - phase sensitive signal detection, Lock-in, measurement of differential (dI(V)/dV) characteristics, tunneling spectroscopy, impedance spectroscopy. AC susceptibility measurements. Kelvin probe measurements. Noises - intrinsic and extrinsic noises, capacitive and inductive coupling, shielding, grounding, noises in amplifiers. Measurement of lifetime, mobility and diffusion length of minority charge carriers by optical methods. Femtosecond spectroscopy - pump-probe measurement. Temperature measurement methods.

Recommended literature:
J.Brož a kol., Základy fysikálních měření (I), SPN, Praha, 1967, pp.532.
J.Brož a kol., Základy fysikálních měření (II)A, SPN, Praha, 1974, pp.295.
J.Brož a kol., Základy fysikálních měření (II)B, SPN, Praha, 1974, pp.756.
K. V. Šalimová, Fyzika polovodičov, Bratislava, 1978, pp. 448
Ralph Morrison, Grounding and Schielding Techniques, 4th edition, John Willey&Sons, Inc., New York, 1998, pp. 201, ISBN 0-471-24518-6.
Henry W. Ott, Noise Reduction Techniques in Electronic Systems, 2nd edition, John Wiley & Sons, New York, 1988, pp.426, ISBN 0-471-85068-3.
J.Jelínek, Z.Málek, Kryogenní technika, SNTL, Praha, 1982, pp.354.

V.Matuáš, Elektronické měžicí přistroje, SNTL/ALFA, Praha, 1981, pp.402.
L. Michalski, K. Eckersdorf, J. Kucharski, J. McGhee, Temperature measurement, 2nd edition, John Wiley & Sons, New York, 2000, ISBN 0-471-86779-9
A.S. Morris, Measurement and Instrumentation principles, Elsevier, Amsterdam, 2001, pp.475, ISBN 0-7506-5081-8
R.B. Northrop, Introduction to instrumentation and measurement, Taylor&Francis, London, 2005, pp.743, ISBN 0-8493-3773-9
E.L.Wolf: Principles of Electron Tunneling Spectroscopy, Oxford University Press, New York, 1989, pp.576.
KEITHLEY: Nanotechnology Measurement Handbook
KEITHLEY: Making precision Low Current and High Resistance Measurements

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested literature is in English)

Notes:

Past grade distribution
Total number of evaluated students: 57

A	B	C	D	E	FX
54,39	24,56	19,3	1,75	0,0	0,0

Lecturers: doc. RNDr. Tomáš Plecenik, PhD.

Last change: 03.12.2021

Approved by: prof. RNDr. Zdenko Machala, DrSc.

STATE EXAM DESCRIPTION

Academic year: 2026/2027	
University: Comenius University Bratislava	
Faculty: Faculty of Mathematics, Physics and Informatics	
Course ID: FMFI.KAFZM/2-FOZ-955/22	**Course title:** Meteorology and Climatology
Number of credits: 6	
Educational level: II.	
Course requirements: Final exam: oral Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50% Scale of assessment (preliminary/final): 0/100	
Learning outcomes: The student consolidates the knowledge and skills acquired during his/her master's study and will understand their interrelationships and the context. He/she will pass the state exam in meteorology and climatology.	
Class syllabus: The syllabi of the exam, which are published in advance, are based on the content of compulsory and optional subjects of block A, but are not strictly linked to them.	
State exam syllabus: Block 1 Compulsory subjects - the student randomly chooses 1 question Environmental physics: 1. Heat engines (maximum efficiency of heat engines, efficiency of real heat engines, efficiency of combined cycle systems) 2. Synthesis (Lawson's criterion) 3. Fission (principle, diffusion, absorption, neutron production, reactor equation, multiplicative factor k) 4. First and second Fick's law, diffusion coefficient and concentration distribution variance 5. Lagrange and Euler representations within continuum mechanics. What they express and how they differ. 6. Navier-Stokes equation, behavior characteristics of the solutions of Navier-Stokes equation Methods of Data Set Analysis: 7. Binomial, Poisson and normal distributions. 8. Chi square distribution, Student distribution, Fischer distribution. 9. Uncertainties of measurements and their propagation (why there are Gaussian uncertainties, CLT, weighted average, combinations of uncertainties, relative uncertainties, systematic and random uncertainties). 10. Estimates - definition of an estimator, requirements for a good estimator, the principle of the maximum likelihood method and the principle of the least squares' method. 11. Hypothesis testing (characteristics, type I and II errors, strength and significance of the test, chi square test, run test (sign test) Spread of pollutants in the environment: 12. Pollutants in the environment, emissions and imissions, vertical thermal stratification and conditions for the dispersion of pollutants in the air.	

13. Mean residence time of substances in the atmosphere, exchange times. Categories of environmental problems: local, regional and global.
14. Atmospheric aerosol, PM particles, benzo(a)pyrene, local heating and transport.
15. Long-distance transmission of pollutants in Europe, acid rains, photochemical smog.
16. Stratospheric ozone, occurrence of ozone holes, legislation on protection of stratospheric ozone layer.
17. Greenhouse effect of the atmosphere, greenhouse gases, GWP, legislation.
18. The cycle of substances on Earth, propagation of pollutants in water.

==========

Block 2 - Compulsory elective courses A - Synoptic meteorology – the student randomly chooses 1 question

1. Principles of synoptic analysis. Physical significance of surface maps, upper-level maps, relative topography maps. Advantages and disadvantages of the synoptic method. Description of the synoptic situation.
2. Air masses - basic types, properties, identification using synoptic maps and aerological measurements, transformation.
3. Atmospheric fronts - types, basic features, identification, possible severe weather events, connection with pressure formations, with surface and upper-level thermobaric field. The occlusion process.
4. Frontogenesis and frontolysis, physical description of individual influences of frontogenetical function.
5. Cyclones and anticyclones in mid latitudes - conditions of origin, properties, identification on synoptic maps at different stages of development.
6. Cyclones and anticyclones in mid latitudes - the influence of surface and season on development. Rapid cyclogenesis.
7. Lee and Mediterranean cyclogenesis.
8. Four-quadrant model, frontal zone. Jet stream and causes of its formation.
9. Principle of PV method, upper-level and surface PV anomalies, their origin and extinction.
10. Acquisition of satellite and radar measurements. RGB products, characteristics identification of air masses and objects of synoptic analysis through satellite measurements. The radar measurements utilization in synoptic and convective meteorology, basic radar products.

==========

Block 3 - Compulsory elective courses A - Dynamic meteorology - the student randomly chooses 1 question

Physics of the lower atmosphere

1. Geostrophic, gradient, cyclostrophic wind and inertial flow.
2. Ageostrophic wind.
3. Changes in geostrophic wind with altitude.
4. Thermal wind.
5. Equation of pressure tendencies.
6. Slope of the frontal surface. Speed of frontal line.
7. Vorticity equation.
8. Bjerknes, Kelvin circulation theorem.

Dynamic Forecasting Methods

9. Assimilation cycle.
10. Lagrange equations of motion of the second kind for the atmosphere. Main thermodynamic theorems.

11. Energy conservation laws. Continuity equation. Metric and potential simplification, governed equations of motion.
12. Sound waves and surface gravitational waves.
13. Buoyancy gravitational waves.
14. Inertial and Rossby waves.
Solution of atmospheric dynamics equations
15. Barotropic and baroclinic atmosphere. Barotropic instability of atmospheric waves.
16. Shallow water model, conservation of potential vorticity.
17. Numerical conditions of stability in solving differential equations in 1D and 2D dimensional grid.
18. Nonlinear instability and aliasing in numerical solution of differential equations.
19. Spectral methods.
20. Finite element method.
==========
Block 4 - Compulsory elective courses A - Climatology - the student randomly chooses 1 question
General Climatology and Regional Climatology
1. General circulation of the atmosphere. Monsoons. Climatic characteristics resulting from the general circulation of the atmosphere.
2. Radiation in the atmosphere, spectral composition of solar radiation. Solar constant. Changes in solar radiation in the atmosphere (absorption, scattering). Sunshine duration.
3. Temperature of the air and the earth's surface and their daily and annual course. Temperature amplitude changes with height and depth. Spatial distribution of air temperature.
4. Water vapor in the air and its importance. Daily and annual course of air humidity characteristics and their spatial distribution.
5. Atmospheric precipitation. Daily and annual course of precipitation and its distribution on the earth's surface. Snow cover.
6. Local wind systems. Daily and annual wind direction and speed.
7. Characteristics of different types of local climate and microclimate. The impact of orography on the local climate. Anthropogenic influence on the urban climate.
8. Climate change in the geological and historical past of the Earth. Climate change in the 20th century and its causes.
9. Anthropogenic effects on climate. Climate system modeling. Scenarios of changes in individual climatic elements until 2100. Consequences of climate change.
10. Principles and types of climate classifications - conventional climate classifications (Köppen) and genetic climate classifications (Alisov).
11. The climate of Europe, with special regard to the climate of Central Europe.
12. Climate classification of the Slovak Republic and climatic regions according to Konček
Block 5 - Compulsory elective courses A - Atmospheric physics - the student randomly chooses 1 question
Atmospheric boundary layer physics
1. Vertical division of the troposphere. Atmospheric boundary layer and its properties.
2. Turbulent state of the atmosphere. Richardson's number.
3. Turbulent diffusion equation, turbulent diffusion coefficient.
4. Prandtl's theory of turbulent momentum transfer, mixing length, roughness parameter.
5. Wind profile in the ground layer of the atmosphere at indifferent stratification. Lajchtman's exponential law.
6. Distribution of temperature and humidity in the ground layer of the atmosphere. Methods for determining individual turbulence characteristics.
7. Turbulent flow of heat and water vapor in the atmosphere.

8. Total radiation balance and methods for determining its components.
9. Methods for determination of evaporation from soil surface.
10. Ekman's spiral.
Physics of clouds and precipitation
11. General conditions of water vapor condensation in the atmosphere. Condensing cores. Dependence of saturated water vapor pressure on surface curvature.
12. Equilibrium of two phases. Clausius and Clapeyron's equation.
13. Vertically air movements. Adiabatic method of vertical velocity calculation.
14. Kinematic method of vertical velocity calculation. The role of latent heat in the process of cloud and fog formation.
15. Condensation on the ground. Thermodynamic conditions of mist formation.
16. Formation of a cloud drop by condensation of water vapor. Coagulation of condensation nuclei. Cooling and freezing of water drops.
17. Convection in the atmosphere. Microstructure of convective clouds. CAPE and CIN quantities. Physical processes in the clouds.
18. Type and shape of precipitation. Theory of atmospheric precipitation (Bergeron and Findeisen theory, coalescence theory). Artificial clouds and weather.
19. Dependence of saturation vapor pressure on various factors. The calculation methods of condensation level height.
20. Formation of mist, their structure, water content of fog. Mists formation from radiative cooling and from evaporation.

Recommended literature:
Detailed lists of literature are in the information sheets of individual subjects

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested literature in English).

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-106/15	Methods of Analysis in Meteorology and Climatology

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: solving practical tasks
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Familiarization with the theory of statistical dependence research and time series analysis, which is widely used especially in the study of climate change and variability. Illustrations and solving practical tasks in the field of meteorology and climatology.

Class syllabus:
Analysis of variance (introduction, One-Factor Analysis of variance, Two-Factor Analysis of variance, multifactorial experiments in solving climatological and practical problems. Two-dimensional basic set, statistical investigation of dependence. Correlation in climatology. Linear regression analysis, nonlinear regression. Correlation Ratio, Coefficient of Determination, Correlation Coefficient. Multiple correlation and regression, step regression. Use of analytical equations to express climatic phenomena. Measurement of Association, total and partial association. Basic conditions of time series construction, characteristics of time series analysis. Analysis of individual components of the time series, analytical comparison of time series. Dependence in time series, synchronous and asynchronous correlation. Climate series balancing. Homogeneity tests of time series (parametric and nonparametric).

Recommended literature:
Nosek, M.: Metody v klimatologii. Praha, Academia 1972. 431s.
General Climatology 1B: Elements of Statistical Analysis. World Survey of Climatology, Vol. 1B, The Netherlands, 1985. 424s.
Lamoš, F., Potocký, F.: Pravdepodobnosť a matematická štatistika, štatistické analýzy. Bratislava, Alfa 1989. 342s.
Sheldon M. Ross: Introductory statistics. Third edition. Elsevier 2010, 818p.

Guide to Climatological Practices. WMO – No.100, Geneva, 1983

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 22

A	B	C	D	E	FX
86,36	4,55	4,55	4,55	0,0	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Ingrid Damborská, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB+KAFZM/2-FOZ-108/22	Methods of Data Set Analysis

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Exam: written and oral exam, successful completion of the written part is condition of the oral part.
Share in the overall rating: 80/20.
Indicative assessment scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By completing the course, students gain basic knowledge of probability theory and mathematical statistics for the purpose of processing bulk data and their evaluation using statistical means, as well as practical experience in solving problems in the field of environmental physics, meteorology and climatology.

Class syllabus:
Basic concepts, stages of statistical research and technique of statistical file processing, numerical characteristics of the frequency distribution (moments, quantiles, mean values, measures of variability, skewness, peaks and concentrations, standardized variable, characteristic function). Theoretical distributions - Binomial, Poisson, Gauss, Chi-square, Student, Fischer and their practical application. Uncertainties, central limit theorem, working with uncertainties, combining uncertainties, systematic uncertainties. Estimates - properties of estimators, likelihood function, maximum likelihood method, moment method. Least squares method - linear fit, weighted linear fit, extrapolation, systematic uncertainties and linear fit, regression, nonlinear least squares method. Probability and confidence - basic concepts, Bayesian statistics, confidence level, confidence interval, areas of confidence, Decision making - hypothesis testing.

Recommended literature:
Metódy spracovania experimentálnych údajov / Ludmila Kubáčková. Bratislava : Veda, 1990
Metody v klimatologii / Miloš Nosek. Praha : Academia, 1972;
Introductory statistics. Third edition / Sheldon M. Ross: Elsevier 2010;
Statistics (A Guide to the Use of Statistical Methods in the Physical Sciences) / R. Barlow. Chichester, England : John Wiley & Sons, 1999 (The Manchester physics series);

Statistical Data Analysis / G. Covan. Oxford : Clarendon Press, 1998 (Oxford Physics series).

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 51

A	B	C	D	E	FX
37,25	31,37	15,69	11,76	3,92	0,0

Lecturers: doc. RNDr. Ivan Sýkora, PhD., RNDr. Ingrid Damborská, CSc., doc. RNDr. Miroslav Ješkovský, PhD.

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-202/10	Nuclear Energy and the Environment

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
The course assessment consists of test (20%), and final oral exam (80%).
Grading: A (100-91), B (90-81), C (80-71), D (70-61), E (60-51), Fx (50-0).
Scale of assessment (preliminary/final): Practical work 20% (test) / 80% final exam.
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Students will learn about the physical nature of nuclear energy and its use, with emphasis on the importance of nuclear energy for the technical and economic development of society and its impact on the environment.

Class syllabus:
General laws governing nuclear reactions with neutrons. Interaction of neutrons with the material environment. Neutron deceleration and diffusion. Activation of materials by neutrons. Fission of atomic nuclei. Chain reaction, multiplication factor. Critical equation in one and two group approximation. Short and long term kinetics of nuclear reactors. Design and types of nuclear reactors. Reactors of the IV. Generation. Thermonuclear reactors. Main parts of a nuclear power plant. Exchangers. Circulation pumps. Piping and fittings. Steam turbines. Protective envelope. Barbotage technique. Effect of radiation on corrosion. Moderators and reflectors. Modeling the transfer of radioactivity from nuclear waste repositories to the environment. Physics of the start-up of a nuclear power plant. Decommissioning of nuclear power plants. Radiation sources and their shielding. Shielding of nuclear sources. Transfer of radioactivity in the primary circuit of a nuclear reactor. Radioactive waste. Economics of nuclear power. Nuclear energy and the environment.

Recommended literature:
P. Otčenášek: Základy konstrukce a funkce jaderných elektráren, Skriptá ČVUT v Prahe, 2003
V. Slugeň a kol.: Jadrové zariadenia, jadrová bezpečnosť, SNUS, 2009
M. Florek: Experimentálna jadrová a subjadrová fyzika: Časť neutrónová fyzika. Univerzita Komenského v Bratislave, 1992

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 32

A	B	C	D	E	FX
68,75	12,5	9,38	6,25	3,13	0,0

Lecturers: Ing. Jakub Kaizer, PhD., doc. RNDr. Miroslav Ješkovský, PhD., doc. RNDr. Monika Müllerová, PhD.

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FJF-138/00	Nuclear Geophysics and Astrophysics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Interim evaluation: test
Final assessment: oral examination
Indicative rating scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
To point to the application of nuclear-physical knowledge in the field of astrophysics and cosmology, as well as to the interconnectedness of these disciplines and to teach basic knowledge about the production of applications of cosmogenic and primordial nuclides.

Class syllabus:
1. Big Bang and Nucleosynthesis
2. r and with processes,
3. The formation of the megastructure of the universe,
4. formation of the solar system,
5. Meteorites - their origin, properties,
6. The inner and outer planets of the solar system,
7. Cosmic radiation,
8. Nuclear reactions of cosmic radiation
9. Production of cosmogenic nuclides in extraterrestial objects,
10. the production of cosmogenic nuclides in the Earth's atmosphere,
11. in situ production of cosmogenic nuclides.
12. Isotopic dating methods

Recommended literature:
Cosmic rays and particle physics by Thomas K. Gaisser. Cambridge : Cambridge University Press, 1992
Theoretical astrophysics : Volume 1 : Astrophysical processes / T. Padmanabhan. Cambridge : Cambridge University Press, 2000

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 39

A	B	C	D	E	FX
66,67	23,08	5,13	5,13	0,0	0,0

Lecturers: prof. RNDr. Jozef Masarik, DrSc., doc. Mgr. Róbert Breier, PhD.

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-122/22	Optical and Laser Spectroscopy

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
After completing the course, the student will have knowledge of several laser spectroscopic methods and their advantages over classical spectroscopic methods. He will know in which applications these methods can be used. It will be able to design a suitable and stable optical resonator.

Class syllabus:
Principles of interaction of radiation with particles. Einstein's coefficients. Basic principles of absorption and emission/excitation spectroscopic methods. Absorption and emission line, its profile and broadening. Instrumentation (radiation sources, dispersive elements, interferometers, detectors, ...). Comparison of classical and laser spectroscopic methods, explanation of why it is advantageous to use a laser. Extension of the absorption path, optical resonator. Laser - in terms of its usefulness in spectroscopy. Classical absorption methods (UV-Vis, IR) compared to laser (intercavity laser induced spectroscopy, cavity enhanced absorption spectroscopy, cavity ring down spectroscopy), Optical plasma emission spectroscopy, Classical and laser fluorescence spectroscopy, laser photoionization spectroscopy. Raman spectroscopy and its comparison with Coherent-Antistokes Raman Scattering spectroscopy.

Recommended literature:
Laserová spektroskopia / Zuzana Chorvátová. Bratislava : Univerzita Komenského, 1992
Laser spectroscopy : Basic concepts and instrumentation / Wolfgang Demtröder. Berlin : Springer, 1981
Optics and lasers : Including fibers and optical waveguides / Matt Young. Berlin : Springer, 2000

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 3

A	B	C	D	E	FX
66,67	33,33	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Mário Janda, PhD.

Last change: 08.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KEF/2-FOL-115/22	Optics and Lasers

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Exam: oral
Indicative assessment scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
The student will gain basic knowledge of optics, spectrometers, detectors, lasers and their applications.

Class syllabus:
Spectral areas from vacuum UV to IR area. Optical properties of materials. Spectrometers (prismatic, cross - sectional). Vacuum UV spectroscopy, UV-NIR, IR region (specific). Interferometers. Optical fibers. Detectors (photodiode, CCD, iCCD, EMCCD, photomultiplier, photon counting mode). Spectral sensitivity calibration methods. Radiation sources. Lasers (laser generation conditions, optical resonator, best known lasers and special laser systems). Properties of laser radiation. Examples of laser applications.

Recommended literature:
General physics: 3: optics / Anton Štrba. Bratislava: Alfa, 1979
Light: Waves, rays, photons / Anton Štrba, Vladimír Mesároš, Dagmar Senderáková. Nitra: Enigma, 2011

Languages necessary to complete the course:
English

Notes:

Past grade distribution
Total number of evaluated students: 39

A	B	C	D	E	FX
58,97	20,51	7,69	5,13	7,69	0,0

Lecturers: prof. RNDr. Pavel Veis, CSc., Mgr. Michaela Horňáčková, PhD.

Last change: 18.02.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAI/2-MXX-132/23	Participation in Empirical Research

Educational activities:
Type of activities: course
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:

Learning outcomes:

Class syllabus:

Recommended literature:

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 202

A	B	C	D	E	FX
89,6	1,49	1,49	0,0	2,97	4,46

Lecturers: Mgr. Xenia Daniela Poslon, PhD.

Last change: 06.09.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAI/2-MXX-132/23	Participation in Empirical Research

Educational activities:
Type of activities: course
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:

Learning outcomes:

Class syllabus:

Recommended literature:

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 202

A	B	C	D	E	FX
89,6	1,49	1,49	0,0	2,97	4,46

Lecturers: Mgr. Xenia Daniela Poslon, PhD.

Last change: 06.09.2023

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB+KEF/2-FBF-102/00	Physical Chemistry and Electrochemistry

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Continuous assessment: homework
Exam: oral
The evaluation of the subject takes place in the form of continuous (individual work -20% of total score) and final evaluation (oral exam). Successful completion of the course reflects the student's sufficient orientation in the issue. The course will be graded as provided the student demonstrates compliance with at least 51%. The conditions for successful completion of the course are in accordance with the Study Regulations of FMFI UK
Indicative assessment scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
The student will have developed a basic apparatus for understanding the physical nature of chemical processes, which may be encountered in other subjects (biochemistry, bioenergetics, plasma physics) as well as with the principles of some analytical methods used e.g. in biophysics.

Class syllabus:
Thermochemistry, creative, reaction and bond enthalpies, their use. Fundamentals of chemical thermodynamics, chemical potential and its application to the study of equilibrium processes. Fugacity, fugacity coefficient, activity, activity coefficient. Chemical equilibrium, equilibrium constant and its dependence on state variables. Affinity of a chemical reaction, conditions of spontaneous chemical course. reactions. Acid-base reactions and the theory of acids and bases. Galvanic cell, electrode potential, its use for measuring physico-chemical quantities. Introduction to chemical kinetics. Reaction order, methods of determining the reaction order. Reaction mechanisms and their relation to the kinetic equation. Homogeneous and heterogeneous catalysis. Autocatalysis, oscillating reactions.

Recommended literature:
http://www.chem1.com/acad/webtext/virtualtextbook.html

Languages necessary to complete the course:

english

Notes:

Past grade distribution
Total number of evaluated students: 120

A	B	C	D	E	FX
63,33	28,33	4,17	0,0	0,0	4,17

Lecturers: Mgr. Petra Ličková, PhD., doc. RNDr. Peter Papp, PhD.

Last change: 18.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-110/00	Physical Education and Sport (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
Practicing of the students´ game skills in collective sports: basketball, volleyball, football, floorball and hockey. Mastering of the basic technique of a particular sport discipline in other sports. In paddling, basic training on still and slightly flowing water. Development of coordination skills, improvement of articular mobility and cardiovascular system.

Recommended literature:

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 2007

A	B	C	D	E	FX
97,41	0,6	0,1	0,0	0,0	1,89

Lecturers: PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, Mgr. Jana Leginusová, Mgr. Tomáš Kuchár, PhD., PaedDr. Mikuláš Ortutay, Mgr. Martin Dovičák, PhD., Mgr. Júlia Raábová, PhD., Mgr. Branislav Nedbálek, PhD., Mgr. Tomáš Lovecký, Mgr. Martina Maheľová, PaedDr. Lucia Ondrušová

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-120/00	Physical Education and Sport (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
Practicing of offensive and defensive game combinations and playing with modified rules in collective sports such as basketball, volleyball, football, floorball, hockey. Command of elements of higher difficulty in locomotion skills (swimming - crawl stroke, breast stroke, butterfly stroke, trampoline jumping and aerobics – practicing of areobics compositions, bodybuilding – development of the main muscle groups, paddling on running water. Testing of the level of physical fitness and coordination skills.

Recommended literature:

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 1797

A	B	C	D	E	FX
98,44	0,33	0,06	0,06	0,06	1,06

Lecturers: Mgr. Martin Dovičák, PhD., Mgr. Tomáš Kuchár, PhD., Mgr. Jana Leginusová, PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, Mgr. Branislav Nedbálek, PhD., PaedDr. Mikuláš Ortutay, Mgr. Júlia Raábová, PhD., Mgr. Tomáš Lovecký, Mgr. Martina Maheľová, PaedDr. Lucia Ondrušová

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-210/00	Physical Education and Sport (3)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3., 9.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
To improve offensive and defensive game combinations in collective sports. Practicing of tactical and technical elements in individual sports. Compensatory exercises to correct wrong body posture. Stretching. Competition rules in sport disciplines.

Recommended literature:

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 1525

A	B	C	D	E	FX
98,36	0,39	0,07	0,0	0,07	1,11

Lecturers: PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, Mgr. Jana Leginusová, Mgr. Tomáš Kuchár, PhD., PaedDr. Mikuláš Ortutay, Mgr. Martin Dovičák, PhD., Mgr. Júlia Raábová, PhD., Mgr. Branislav Nedbálek, PhD., Mgr. Tomáš Lovecký, Mgr. Martina Maheľová, PaedDr. Lucia Ondrušová

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-220/00	Physical Education and Sport (4)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4., 10.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:

Class syllabus:
Sport training for Faculty Championships in a selected sport with modified rules. Selection of sport-talented students into teams of the Faculty Sport League, University League of Bratislava Faculties, and participation in sport events of the Faculty and University.

Recommended literature:

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 1267

A	B	C	D	E	FX
98,34	0,39	0,08	0,08	0,08	1,03

Lecturers: PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, Mgr. Jana Leginusová, Mgr. Tomáš Kuchár, PhD., PaedDr. Mikuláš Ortutay, Mgr. Martin Dovičák, PhD., Mgr. Branislav Nedbálek, PhD., Mgr. Júlia Raábová, PhD., Mgr. Tomáš Lovecký, Mgr. Martina Maheľová, PaedDr. Lucia Ondrušová

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-113/00	Physics of Clouds and Precipitation

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
The student will gain basic knowledge about the mechanisms of cloud formation and precipitation, microstructure and cloud macrostructure, special cloud and precipitation problems.

Class syllabus:
Thermodynamics of phase transitions. Condensation nuclei and mechanisms of their action. Methods of calculating vertical speeds in the atmosphere. Vertical flows in the boundary layer of the atmosphere. Condensation of water vapor in the ground layer of the atmosphere. Thermodynamic conditions of the formation of masses. Convection in the atmosphere, macrostructic and layered cloud cover, CAPE and CIN quantities. Cloud microstructure and physical processes in the clouds. Theory of condensation growth of cloud drops and ice particles. Coalescence in the atmosphere and coalescent growth of cloud drops. The theory of the origin of precipitation (Bergeron and Findeisen's theory, the coalescent theory). Physical conditions for precipitation in the ground layer of the atmosphere. Precipitation measurement errors. Physical aspects of the formation and changes of snow cover. Electrical and optical properties of clouds and precipitation. Artificial interventions in clouds and precipitation.

Recommended literature:
Řezáčová, D., Novák, P., Kašpar, M., Setvák, M. (2007): Fyzika oblaků a srážek. Academia, Praha, 574 s.
Khvorostyanov V.I. a Curry J.A. (2014): Thermodynamics, kinetics and microphysics of Clouds, Cambridge Press, Oxford
Wang et al (2013): Physics and Dynamics of Clouds and Precipitation, Cambridge Press, Oxford
Chrgijan, A., Ch. (1978): Fizika atmosfery, Tom 1, 2, Gidrometeoizdat - Leningrad, 247 s. a 319 s.

Pruppacher H.R., Klett J.D. (1997): Microphysics of Clouds and Precipitation. Kluwer Academic Publishers, Oxford

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 42

A	B	C	D	E	FX
57,14	26,19	11,9	4,76	0,0	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Ingrid Damborská, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-249/22	Physics of Convective Phenomena

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: II.

Prerequisites:

Recommended prerequisites:
Synoptic Meteorology (1) (2-FMK-107/22); Synoptic Meteorology (2) (2-FMK-102/00); Physics of Lower Atmospheric Layers (2-FOZ-107/15)

Antirequisites: FMFI.KAFZM/2-FMK-249/00

Course requirements:
Preliminary evaluation: case study analysis
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Students will be able to understand the basic physical processes related to deep moist convection and recognize the environment in which storms and their individual accompanying severe phenomena occur. They also will be able to identify the typical characteristics of these environments and their relationship with convective mode. Students will gain a basic overview of current research methods of convective phenomena.

Class syllabus:
Basic physical quantities, parameters and equations describing the development of deep moist convection. Pressure perturbation gradient force, vorticity equation, vertical wind shear and its significance. Parcel theory and its shortcomings, potential energy, CAPE and CIN index.
Spectrum of convective modes - ordinary convective cell, mesoscale convective systems, supercells - lifecycle, typical environment, features on radar and satellite images, gust front, RKW theory, typical accompanying phenomena, real cases.
Severe phenomena: heavy rain, large hail, severe wind and downburst, tornado - typical environments and their prediction, connection with convective modes.
Currently used prediction methods: e.g. ingredient-based method and explicit prediction of convective phenomena by high resolution models. Situation analysis through observations, radar and satellite data in combination with numerical models, interpretation of outputs from aerological

soundings and identification of basic environmental properties, influence of synoptic scale processes, convective forecast indices and their limitations, hodographs, electrical activity of thunderstorms and its relation to the intensity of accompanying phenomena. Influence of orography on the environment of convective phenomena.
Application of knowledge in practice - short-term prediction of severe convective phenomena and nowcasting in a real atmosphere. Early warning methods against severe convective phenomena.
Modern research methods of deep convection (machine learning, explicit convection modeling, research and operational numerical models and their possibilities, probabilistic prediction).

Recommended literature:

Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Burgess, D. W., , and L. R. Lemon, 1990: Severe thunderstorm detection by radar. Radar in Meteorology, D. Atlas, Ed., Amer. Meteor. Soc., 619–647.
Coffer, B. E., and Parker, M. D., 2017: Simulated Supercells in Nontornadic and Tornadic VORTEX2 Environments. Monthly Weather Review 145, 1, 149-180.
Davies-Jones, R., 2015: A review of supercell and tornado dynamics. Atmos. Res., 158–159, 274–291.
Dennis, E.J. and Kumjian, M.R., 2017. The impact of vertical wind shear on hail growth in simulated supercells. Journal of the Atmospheric Sciences, 74(3), pp.641-663.
Doswell, C.A., H.E. Brooks, and R.A. Maddox, 1996: Flash Flood Forecasting: An Ingredients-Based Methodology. Wea. Forecasting, 11, 560–581.
Fritsch, J.M. and G.S. Forbes, 2001: Mesoscale Convective Systems. Meteorological Monographs, 50, 323–358.
Klemp, J.B., 1987. Dynamics of tornadic thunderstorms. Annu. Rev. Fluid Mech. 19, 369–402.
Kuchera, E.L. and Parker, M.D., 2006. Severe convective wind environments. Weather and forecasting, 21(4), pp.595-612.
Marion, G. R., Trapp, R. J., 2019: The dynamical coupling of convective updrafts, downdrafts, and cold pools in simulated supercell thunderstorms. Journal of Geophysical Research: Atmospheres, 124(2), 664-683.
Markowski, P., Richardson, Y., 2010: Mesoscale meteorology in midlatitudes. Wiley-Blackwell.
Markowski, P. M., and Richardson, Y. P., 2014: The Influence of Environmental Low-Level Shear and Cold Pools on Tornadogenesis: Insights from Idealized Simulations. Journal of the Atmospheric Sciences 71, 1, 243-275.
Mulholland, J. P., Nesbitt, S. W., Trapp, R. J., Peters, J. M., 2020: The Influence of Terrain on the Convective Environment and Associated Convective Morphology from an Idealized Modeling Perspective, Journal of the Atmospheric Sciences, 77(11), 3929-3949.
Peters, J. M., Nowotarski, C. J., Morrison, H., 2019: The Role of Vertical Wind Shear in Modulating Maximum Supercell Updraft Velocities, Journal of the Atmospheric Sciences, 76(10), 3169-3189.
Púčik, T., Groenemeijer, P., Rýva, D., Kolář, M., 2015: Proximity soundings of severe and nonsevere thunderstorms in central Europe. Monthly Weather Review, 143(12), 4805-4821.
Rotunno, R., J.B. Klemp, and M.L. Weisman, 1988: A Theory for Strong, Long-Lived Squall Lines. J. Atmos. Sci., 45, 463–485.
Taszarek, M., Brooks, H. E., Czernecki, B., 2017: Sounding-Derived Parameters Associated with Convective Hazards in Europe. Monthly Weather Review 145, 4, 1511-1528.
Taszarek, M., Allen, J.T., Púčik, T., Hoogewind, K., Brooks, H., 2020: Severe Convective Storms across Europe and the United States. Part II: ERA5 Environments Associated with Lightning, Large Hail, Severe Wind, and Tornadoes. Journal of Climate, 33, 10263-10286.

Thompson, R. L., Smith, B. T., Grams, J. S., Dean, A. R., Broyles, C., 2012: Convective modes for significant severe thunderstorms in the contiguous United States. Part II: Supercell and QLCS tornado environments. Weather and forecasting, 27(5), 1136-1154.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 4

A	B	C	D	E	FX
0,0	25,0	50,0	25,0	0,0	0,0

Lecturers: Mgr. Miroslav Šinger, PhD., Mgr. Tomáš Púčik, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-107/15	Physics of Lower Atmospheric Layers

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 3 / 1 **per level/semester:** 39 / 13
Form of the course: on-site learning

Number of credits: 5

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: independent work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
To explain the elementary knowledge of atmospheric dynamic.

Class syllabus:
The horizontal flows and their classification. The advective changes of temperature by geostrophic wind. The ageostrophic wind. The altitude change of geostrophic wind in the various oriented thermobaric field. The time changes of temperature and air pressure in the dependence to direction and changes of geostrophic wind by altitude. Thermal wind. Slope of isobaric and frontal surfaces. Frontogenesis and frontolysis. Speed of frontal line. Continuity equation and pressure tendency equation, Vorticity equation. Bjerknes, Kelvin circulation theorem.

Recommended literature:
Pechala, F., Bednář, J.:Příručka dynamické meteorologie. Academia, Praha, 1991, 372s.
Holton, J.R.: An Introduction to Dynamic Meteorology. Academic Press, London, 1992, 511p.
Tomlain, J., Damborská, I.: Fyzika hraničnej vrstvy atmosféry. Vyd.UK Bratislava, Bratislava, 1999, 132s.
Bluestein, H.B.: Synoptic-Dynamic Meteorology in Midlatitudes, Vol.1, Oxford Univ.Press., 1992, 431 pp.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution Total number of evaluated students: 46					
A	B	C	D	E	FX
36,96	21,74	21,74	13,04	6,52	0,0
Lecturers: doc. RNDr. Martin Gera, PhD.					
Last change: 14.03.2022					
Approved by: prof. RNDr. Zdenko Machala, DrSc.					

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-204/22	Practical Training in Radiation Monitoring

Educational activities:
Type of activities: laboratory practicals
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: submission of laboratory protocols.
Final exam: presentation of the results.
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 80/20

Learning outcomes:
Students will gain experience with different types of dosimetric measurements and monitoring of radioactivity in the environment.

Class syllabus:
Monitoring of radioactivity in soils (determination of 14C, 137Cs, 40K, 226Ra, 232Th) - use of separation methods for different radionuclides, monitoring of radioactivity in water (determination of 3H, 14C, 222Rn) - use of liquid scintillation methods and gas detectors, determination of atmospheric radioactivity (measurement of 7Be, 14C, 3H concentrations) - use of gamma spectrometric methods, gas detectors and liquid scintillation.

Recommended literature:
Detekcia a spektrometria žiarenia alfa a beta / Štefan Šáro. Bratislava : Alfa, 1984
Gamma- nd X-Ray spectrometry with semiconductor detectors / Klaus Debertin, Richard G. Helmer. Amsterdam : Elsevier, 1988

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 29

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Ivan Sýkora, PhD., doc. RNDr. Monika Müllerová, PhD., Mgr. Ivan Kontuľ, PhD., RNDr. Terézia Eckertová, PhD.
Last change: 21.06.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-121/22	Practice of Analytical Methods in Environmental Physics

Educational activities:
Type of activities: course
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Recommended prerequisites:
Analytical Methods of Environmental Physics (1-OZE-342/15)

Course requirements:
Preliminary evaluation: elaboration of laboratory protocols
Final exam:
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
The student will gain practical experience with analytical methods in environmental physics for the analysis of solids, liquids, gases and plasma.

Class syllabus:
Calibration measurements of gases (nitrogen oxides NOx, carbon oxides COx and hydrocarbons HC) and liquids (hydrogen peroxide H2O2, nitrates $NO2^{-}$, nitrites $NO3^{-}$, ozone O3). Infrared absorption spectroscopy - analysis of gaseous, liquid and solid samples by various transmission and reflection techniques. Gas chromatography - analysis of gaseous and liquid samples. UV-VIS and fluorescence spectroscopy - chemical and biological analysis of solutions. Electrochemical measurements of gases and vapors. Optical emission and absorption UV-VIS spectroscopy of plasma.

Recommended literature:
S.K. Dogra: Molecular spectroscopy, Tata McGraw Hill (2012)
B. C. Smith: Fundamentals of FTIR, CRC Press (1996)
J. R. Lakowicz: Principles of fluorescence spectroscopy, Springer (2006)
H. M. NcNair and J. M. Miller: Basic gas chromatography, Wiley (2009)

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 7

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Mário Janda, PhD., Mgr. Katarína Szárazová, PhD., doc. RNDr. Karol Hensel, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-142/22	Practice of Meteorological Instruments and Observation Methods

Educational activities:
Type of activities: laboratory practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: homework / written work / reports
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
After completing the course, students will have an overview of measuring and observation methods of meteorological elements. They will get acquainted with the basic physical principles of the most used devices, with the methodology of measurement, analysis and processing of measured data from individual devices. They will gain experience in working with the most current WMO manuals concerning the measurement and observation of meteorological elements.

Class syllabus:
-measurement of air temperature, units and scales, requirements for thermometers, thermometers according to the principle of operation, work with thermometers; maximum, minimum, ground
-humidity measurement, quantities characterizing humidity and their units, requirements for hygrometers, hygrometers according to the principle of operation
- precipitation measurement, rain gauges according to the principle of operation, location of rain gauges, corrections, requirements for rain gauges
-pressure measurement, pressure gauges according to the principle of operation, requirements for pressure gauges, pressure reduction to sea level
-measurement of wind speed and direction, anemometers according to the principle of operation, accuracy requirements
-measurement of sunlight and radiation in the atmosphere, measurement of various components of radiation
-measibility measurement: transmission meter, forwardscatter, cameras
-cover and cloud height, ceilometer, cameras
-calibration of individual devices

Recommended literature:

Guide to Instruments and Methodsof Observation, Volume I –Measurement of Meteorological Variables, WMO-No.8, 2018 and later

Languages necessary to complete the course:
Slovak and English

Notes:

Past grade distribution
Total number of evaluated students: 40

A	B	C	D	E	FX
92,5	7,5	0,0	0,0	0,0	0,0

Lecturers: RNDr. Juraj Bartok, PhD., prof. RNDr. Milan Lapin, CSc.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-115/22	Professional Pre-diploma Practice

Educational activities:
Type of activities: practice
Number of hours:
per week: **per level/semester:** 4t
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual work
Final exam:
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Familiarization with the work of the synoptic meteorological service and the content of the work of the selected workplace according to the focus of the thesis in order to solve at least some questions and topics of the thesis according to its curriculum.

Class syllabus:
Familiarization with the focus of the Department of Weather Forecasting of the SHMÚ, the organization of the service in the general forecasting department, the scope of information issued, the work related to the preparation and distribution of weather forecasts, the issuing of warnings for dangerous hydrometeorological phenomena, the nowcasting system INCA, the outputs of forecast numerical models (model ALADIN, ECMWF model) and satellite observation systems EUMETSTAT, with the course of consultations on the expected development of weather. Detailed familiarization with the activity of the workplace according to the focus of the thesis, addition and acquisition of new knowledge in the field related to the topic of the thesis.

Recommended literature:
According to the instructions of the head of the thesis.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 39

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: RNDr. Ingrid Damborská, CSc., prof. RNDr. Milan Lapin, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FJF-126/00	Radiation Environmental Physics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Final assessment: written examination, oral examination
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
Students will gain an understanding of the sources, distribution, migration, dispersion, measurement and applications of radionuclides in the environment.

Class syllabus:
1. Sources of ionizing radiation in the biosphere. Primordial and cosmogenic radionuclides.
2. Anthropogenic radionuclides. Ecologically significant radionuclides, radiotoxicity.
3. Distribution, migration and transport of radionuclides in nature.
4. Basic characteristics of radon, solubility, potential alpha energy, equivalent activity concentration.
5. Accumulation of radon decay products.
6. Radon in the outdoor atmosphere, in soil and in living quarters, risk of exposure.
7. Methods of monitoring environmental contamination and environmental processes, reasons for measurement of 226Ra, 232Th, 40K in soils and building materials
8. Measurement of radioactivity in the atmosphere, soil and water, measurement of 222Rn in living quarters and soil.
9. Neutron activation and X-ray fluorescence analysis of environmental pollutants.
10. Effective dose from inhalation of radionuclides.
11. Dose rate from terrigenous radionuclides.
12. Use of radionuclides as tracers of natural processes.
13. National regulations and international recommendations for protection against ionizing radiation.

Recommended literature:
Holá O., Holý K.: Radiačná ochrana : Ionizujúce žiarenie, jeho účinky a ochrana pred ionizujúcim

žiarením. - 1. vyd. - Bratislava : Slovenská technická univerzita, 2010.
Baskaran M.: Radon: A Tracer for Geological, Geophysical and Geochemical Studies, Springer,2016
R. Tykva, D. Berg: Man-Made and Natural Radioactivity in Environmental Pollution and Radiochronology, Kluwer Academic Publishers, 2004
P.P.Povinec, J.A.Sanchez-Cabeza: Radionuclides in the Environment, Elsevier, 2006

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 69

A	B	C	D	E	FX
62,32	15,94	17,39	1,45	1,45	1,45

Lecturers: doc. RNDr. Monika Müllerová, PhD., RNDr. Terézia Eckertová, PhD.

Last change: 22.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-144/00	Radiation in the Atmosphere

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: homework / written assignments
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
After completing the course, students will be able to understand the importance of solar radiation as a climatic factor and will know the basic processes of absorption and scattering of solar radiation in the atmosphere, as well as the process of transformation of solar radiation.

Class syllabus:
-solar radiation, basic characteristics, laws of absolute black body radiation, spectral composition of solar radiation at the upper limit of the atmosphere, solar constant.
-extinction of solar radiation in the atmosphere, extinction coefficient, expensive sunlight in the atmosphere, molecular scattering of solar radiation, polarization of scattered sky radiation, scattering of solar radiation on dust particles and water droplets, extinction of solar radiation in atmospheric by absorption
-Radiation balance of the Earth's surface, atmosphere and Earth's surface-atmosphere system, direct and scattered solar radiation, global radiation, albedo, shortwave radiation balance, longwave radiation balance, total radiation balance of the Earth's surface, greenhouse effect, radiation balance of the atmosphere, radiation balance of the Earth's system surface-atmosphere
-Radiation balance of differently oriented inclined surfaces, flux of direct, scattered and global radiation on different inclined surfaces, methods of determining daily and monthly amounts of global radiation on differently oriented inclined surfaces.

Recommended literature:
An Introduction to Atmospheric Radiation / K.N. Liou, 2nd Edition Elsevier, 2002

Languages necessary to complete the course:
Slovak and English

Notes:

Past grade distribution
Total number of evaluated students: 31

A	B	C	D	E	FX
77,42	22,58	0,0	0,0	0,0	0,0

Lecturers: RNDr. Juraj Bartok, PhD., prof. RNDr. Milan Lapin, CSc.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-201/22	Radioecology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Final exam: written / oral examination
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By using experimental data and modeling, students will gain knowledge about the movement of radionuclides in the environment and the impact of radioactivity on organisms at different trophic levels.

Class syllabus:
Natural radionuclides. Sources of anthropogenic radionuclides. Dispersion of radioactive materials in the atmosphere. Primary fluence. Ecological concepts in radioecology. Radionuclide transfer in seas, lakes and agriculture. Ingestion and inhalation as a cause of exposure of the population. Effects of ionizing radiation on ecosystems and populations. Sampling and processing in radioecology. Radiochemical separation techniques. Analytical methods for the determination of radioactivity. Reference animals and plants. Kinetic and dynamic models. Environmental dosimetry. ERICA tool.

Recommended literature:
E. Holm (ed.): Radioecology – Lectures in Environmental Radioactivity, Lund University (1994).
F. F. Luykx, M. J. Frissel (ed.): Radioecology and the Restoration of Radioactive-Contaminated Sites, Kluwer Academic Publishers (1996).
International Atomic Energy Agency: Safety Series Report No. 19, IAEA (2001).
International Commission on Radiological Protection: ICRP Publication 108, ICRP (2008).

Languages necessary to complete the course:
Slovak, English

Notes:

Past grade distribution
Total number of evaluated students: 1

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Miroslav Ješkovský, PhD., Ing. Jakub Kaizer, PhD.

Last change: 17.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJFB/2-FOZ-242/15	Radionuclides Monitoring Methods

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Exam: written and oral exam, successful completion of the written part is condition of the oral part.
Share in the overall rating: 80/20.
Indicative assessment scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
After completing the course, students will gain knowledge about the basic methods of monitoring radionuclides in various components of the environment.

Class syllabus:
Basic principles of radioactivity measurement, sources of radioactivity in the environment, Specifics of radioactivity measurements, Basic characteristics of detectors, Gas, semiconductor and scintillation radiation detectors, Methods of measuring volume activity. Criteria for method selection, sampling, adjustment, optimization of measurement conditions, concept of low activity, quality coefficient, detection limits. Background, an overview of methods of reducing it. Analysis of samples containing alpha emitters. Determination of beta-emitter activity. Determination of detection efficiency for quenching samples. Methods for determination of tritium and radiocarbon. Gamma spectrometry of environmental samples. Instrument spectrum processing. Spectrometric chain with semiconductor detector. Methods of monitoring radioactivity of the atmosphere, methods of monitoring radioactivity of soil and water, applications of monitoring methods.

Recommended literature:
S. Usačev a kol.: Experimentálna jadrová fyzika, Alfa, Bratislava, 1982,
J. Šeda a kol.: Dozimetrie ionizujúcího záření, SNTL, Praha, 1983,
Š. Šáro: Detekcia a spektrometria žiarenia alfa a beta, Alfa, Bratislava, 1983,
G. F. Knoll: Radiation detection and measurements, J.Wiley & Sons, NewYork, 2000,
W. R. Leo: Techniques for Nuclear and Particle Physics Experiments, Springer Verlag, 1994,
K. Kleinknecht: Detectors for particle radiation, Cambridge University Press, 1998, 246p

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 26

A	B	C	D	E	FX
23,08	23,08	23,08	26,92	3,85	0,0

Lecturers: doc. RNDr. Ivan Sýkora, PhD., Mgr. Ivan Kontuľ, PhD., doc. RNDr. Monika Müllerová, PhD.

Last change: 16.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-116/22	Regional Climatology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: -
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
By completing the course, the student will gain a knowledge about climate classifications and the physics of the Central European climate sub-system, and the climatic conditions in the world, with emphasis on individual regions of Central Europe and Slovakia.

Class syllabus:
Climatic classifications. Climate characteristics according to principal types of climatic classifications. Central European climate sub-system, climate forming factors and processes and their interactions. Climatic patterns for selected climatic elements. Climate and its peculiarities in the individual Central European regions. Dynamic climatology. Climatic classifications for Central Europe. Climatic normals and characteristics of selected Central European cities and in Slovakia at changing climate forming conditions.

Recommended literature:
Klimatické pomery na Slovensku. Zborník prác SHMÚ, zv. 33/I a 33/II, Alfa, Bratislava 1991 a 1990, 239 pp.
Okolowicz, W.: General Climatology Polish Sci.Pub., Warszawa 1976, 422 pp.
Netopil, R. et al.: Fyzická geografie 1.SPN Praha 1984, 272 pp.
Podnebí Československa – Souborná studie (Š. Petrovič, ed.), HMÚ Praha, Severografia, Turnov 1969, 357 pp.
Lapin, M., Tomlain, J.: Všeobecná a regionálna klimatológia, Vyd. UK Bratislava, Bratislava 2001, 184 pp.
Klimatické a fenologické pomery jednotlivých krajov Slovenska, HMÚ Praha a SHMÚ Bratislava.

Atlas krajiny Slovenskej republiky (L. Miklós ed.) MŽP SR Bratislava a AŽP Banská Bystrica 2002, 344 pp.
Climatic normals by the WMO for 1961-1990. WMO, Geneva 1992 (on CD).

Languages necessary to complete the course:
Slovak in combination with English.

Notes:

Past grade distribution
Total number of evaluated students: 59

A	B	C	D	E	FX
45,76	45,76	1,69	5,08	1,69	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., RNDr. Marián Melo, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI-PriF.KMPLG/2-FOZ-302/22	Remediaton Methods of Environmental Burdens

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: Completion of lectures and exercises, elaboration of tasks from practical exercises (in justified cases, one non-participation in one practical is acceptable)
Final exam: Passing the final practical test
Indicative evaluation scale: A 91%, B 81%, C 71%, D 61%, E 50%

Learning outcomes:
After completing this course, students will gain a comprehensive overview of the wide range of remediation methods used in the elimination of pollution of the rock environment, groundwater and surface water as well as soil. The results of education in this subject are beneficial for the application of students in practice in the application of remediation technologies as well as for the application of students in state and public administration in the sector of environmental management.

Class syllabus:
1. Legislative regulations determining the use of remediation methods in practice. 2. Characteristics of natural conditions in relation to the design of remediation, methods of survey of remediated sites. 3. 4. 5. Methods of remediation of the rock environment and solid materials. In-situ and ex-situ remediation methods (Bioventing. Bioremediation. Biodegradation. Phytoremediation and risk remediation. Natural attenuation. Landfarming. Chemical oxidation. Electrodecontamination. Structure disturbance, splitting. Soil washing. Venting and airsparging. Covering, sealing and encapsulation Vitrification Barriers 6. 7. 8. Water remediation methods In-situ and ex-situ remediation methods (Bioventing. Bioremediation. Biodegradation. Natural attenuation. Chemical oxidation / reduction. Electrodecontamination. Washing, venting and airsparging, barriers, passive water treatment systems, 9. methods of soil air and air purification, 10. nanotechnologies for remediation of environmental loads, 11. Combination and integration of remediation methods, 12. 13. Examples of implementation of remediation methods at model localities in the Slovak Republic and the Czech Republic.

Recommended literature:

Frankovská J., Kordík J., Slaninka I., Jurkovič Ľ., Greif V., Šottník P., Dananaj I., Mikita S., Dercová K., Jánová, V., 2010: Atlas sanačných metód environmentálnych záťaží. Štátny geologický ústav D. Štúra, Bratislava, 360 s.
Matějů V. et al., 2006: Kompendium sanačních technologií. Vodní zdroje Ekomonitor, s r. o., Chrudim, 1. vydanie, 280 s.
Ok Y.S. et al. (2020): Soil and Groundwater Remediation Technologies - Practical Guide. CRC Press, Taylor & Francis Goup, 351 s.
Černík M. et al. (2010): Chemicky podporované in situ sanační technologie. Vydavatelství VŠCHT. 336 s.
Study literature as well as other recommended literature is available from the lecturer

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 4

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Ľubomír Jurkovič, PhD., doc. Mgr. Peter Šottník, PhD., Ing. Hana Horváthová, PhD., Mgr. Juraj Macek, PhD.

Last change: 12.10.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-246/00	Remote Sensing in Meteorology

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: elaboration of 1-2 papers
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 80/20

Learning outcomes:
Gain knowledge about the principles and products of remote sensing with regard to their use in meteorology and other related fields.

Class syllabus:
Physical principles of remote sensing. Instrumentation for remote sensing in meteorology: Active - passive sensors, imagery - profilers, radars, lidars, spectrophotometers. Data processing into products. Principles of RGB composites, the most commonly used RGB composites and their interpretation. Detection of meteorological phenomena and elements: different types of clouds, fog, wind fields, snow cover, glaciation, moisture distribution, types of air masses, properties of the earth surface and oceans, total ozone, atmospheric discharges, carbon dioxide concentrations, etc. Detection of non-meteorological phenomena: forest fires, vegetation index, fire risk index. Current trends in remote sensing.

Recommended literature:
Current sources of literature, scientific journals and Internet information will be available from the lecturer on an ongoing basis.
Older literature:
Carlsson, C.G.: An Introduction to Remote Sensing in Meteorology. SHMI, Sweden, Norrkoping 1997,315 pp.
Reinhart, R.E.: Radar for Meteorologists. 2nd ed., North Dakota, USA, 1992, 334 pp.
Rao, P.K. at all.: Weather Satellites – Systems, Data and Environmental Applications, 2nd ed. AMS USA, Boston, 1994, 503 pp
A Feranec, J. a kol: Slovensko očami satelitov, Veda, Bratislava, 2010, 263s.

Feranec, J. a kol: Meniace sa Slovensko očami satelitov +DVD, Veda, Bratislava,2012, 74.
European Organisation for the Exploitation of Meteorological Satellites: MSG Interpretation Guide, EUMETSAT, 2004, https://www.eumetsat.int/msg-interpretation-guide

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 18

A	B	C	D	E	FX
94,44	5,56	0,0	0,0	0,0	0,0

Lecturers: Mgr. Marián Jurášek

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-161/00	Russian Language (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Basic communication in Russian, developing other Russian language skills - listening comprehension, reading and writing.

Class syllabus:
To master the fundamentals of general Russian. The language level is A1.
Learning the Cyrillic (Russian) alphabet, gaining basic language competence, building up skills and confidence in dealing with unfamiliar authentic and semi-authentic texts.
The subject provides a course in Russian language for beginners.

Recommended literature:
The textbook: : Точка Ру A1 (Ольга Долматова, Екатерина Новачац), pracovné karty Падежи 1 (Л.С. Безкоровайная, В.Е. Штыленко).

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 746

A	B	C	D	E	FX
57,77	16,62	11,13	4,16	1,74	8,58

Lecturers: Viktoria Mirsalova

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-162/00	Russian Language (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Basic communication in Russian, developing other Russian language skills - listening comprehension, reading and writing.

Class syllabus:
To master the fundamentals of general Russian.
Learning the Cyrillic (Russian) alphabet, gaining basic language competence, building up skills and confidence in dealing with unfamiliar authentic and semi-authentic texts.
The subject continues the program of Russian language (1) and provides a course of Russian for beginners.

Recommended literature:
Textbook: Точка Ру A1 (Ольга Долматова, Екатерина Новачац), pracovné karty Падежи 1 (Л.С. Безкоровайная, В.Е. Штыленко).

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 435

A	B	C	D	E	FX
63,91	16,09	8,97	3,91	0,92	6,21

Lecturers: Viktoria Mirsalova

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-261/00	Russian Language (3)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3., 9.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Basic communication in Russian, developing other Russian language skills - listening comprehension, reading and writing.

Class syllabus:
Learning the handwritten Russian (Russian Cursive Cyrillic), developing further language skills, gaining knowledge of Russian culture, history and way of life, pre-intermediate to intermediate grammar and vocabulary.
The course "Russian for Intermediate Students" is a follow-up to "Russian for Beginners". The subject of the course is general Russian in the range appropriate to the given level.

Recommended literature:
Точка Ру A2 (Ольга Долматова, Екатерина Новачац) a Short Stories in Russian (Olly Richards, Alex Rowlings)

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 215

A	B	C	D	E	FX
68,84	17,67	9,3	2,33	0,0	1,86

Lecturers: Viktoria Mirsalova

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-262/00	Russian Language (4)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4., 10.

Educational level: I., I.II., II.

Prerequisites:

Course requirements:
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
Learning the handwritten Russian (Russian Cursive Cyrillic), developing further language skills, gaining knowledge of Russian culture, history and way of life, pre-intermediate to intermediate grammar and vocabulary.

Class syllabus:
Learning the handwritten Russian (Russian Cursive Cyrillic), developing further language skills, gaining knowledge of Russian culture, history and way of life, pre-intermediate to intermediate grammar and vocabulary.
The course "Russian for Intermediate Students" is a follow-up to "Russian for Beginners". The subject of the course is general Russian in the range appropriate to the given level.

Recommended literature:
Точка Ру A2 (Ольга Долматова, Екатерина Новачац) a Short Stories in Russian (Olly Richards, Alex Rowlings)

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 153

A	B	C	D	E	FX
74,51	14,38	7,19	2,61	0,65	0,65

Lecturers: Viktoria Mirsalova

Last change: 20.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-202/00	Satellite and Radar Observations of Meteorological Phenomena

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: 2 tests
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 80/20

Learning outcomes:
Gain knowledge about the principles of observing meteorological phenomena using meteorological satellites and radars.

Class syllabus:
History of meteorological radars. Radar block scheme. Radar signal propagation through the atmosphere. Radar equation. Quantities measured by radar. Meteorological phenomena detectable by radar. Problems and their solutions in meteorological radar measurements. Radar measurement products. Meteorological radar network of the Slovak Republic and international data exchange. Electromagnetic spectrum. Physical laws of radiation. Changing the intensity of radiation by passing through a layer. Two stream approximation. Schematic equation for radiation intensity measured by satellite. Types of sensors. Orbits of satellites and meteorological satellites. Sensor signal processing. Principles of RGB composites. Detection of meteorological phenomena using meteorological satellites. EUMETSAT.

Recommended literature:
Current sources of literature, scientific journals and Internet information will be available from the lecturer on an ongoing basis.
Older literature:
Carlsson, C.G.: An Introduction to Remote Sensing in Meteorology. SHMI, Sweden, Norrkoping 1997,315 pp.
Reinhart, R.E.: Radar for Meteorologists. 2nd ed., North Dakota, USA, 1992, 334 pp.
Doviak, R.J., Zrnic, D.S.: Doppler Radar and Weather Observations, Academic Press, London, 1992, 562 pp.

Rao, P.K. at all.: Weather Satellites – Systems, Data and Environmental Applications, 2nd ed. AMS USA, Boston, 1994, 503 pp
Feranec, J. a kol: Slovensko očami satelitov, Veda, Bratislava, 2010, 263s.
Feranec, J. a kol: Meniace sa Slovensko očami satelitov +DVD, Veda, Bratislava,2012, 74

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 65

A	B	C	D	E	FX
96,92	1,54	1,54	0,0	0,0	0,0

Lecturers: prof. RNDr. Milan Lapin, CSc., Mgr. Marián Jurášek

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-278/22	Selected Topics of Renewable Energy Sources

Educational activities:
Type of activities: seminar
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: elaboration of selected topic and presentation at seminar
Final exam: -
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
The aim of the seminar is to open a discussion on selected topics related to renewable energy sources (with emphasis on wind and hydropower and energy storage methods), as well as to deepen students' knowledge of renewable energy sources. By completing the seminar, the student will deepen their experience with the gathering, analysis and processing of relevant data and literature on a pre-selected topic. In addition, the student will improve their presentation skills in presenting the selected topic.

Class syllabus:
Energy Return On Investment (EROI) of renewable energy sources (RES).
Carbon footprint of selected types of RES.
Critical evaluation of the impact of selected types of RES on the environment.
Small vs. large hydropower plants.
Small vs. big wind turbines.
Current vs. future technologies of selected types of RES.
Current vs. future energy storage technologies.
High-capacity energy storage.
Is an electric car really more ecological than a car with internal combustion engine?
and other relevant topics.

Recommended literature:
M. Morvová: Princípy metód a využitie obnoviteľných zdrojov energie, Knižničné a edičné centrum FMFI UK (2008);
D. J. C. MacKay: Obnoviteľné zdroje energie – s chladnou hlavou, Slovenská inovačná a energetická agentúra (2013);

R. Ehrlich, H. A. Geller: Renewable Energy – A First Course, CRC Press (2018);
J. Andrews, N. Jelley: Energy Science: Principles, Technologies, and Impacts, Oxford University Press (2007).
and other current literature and articles available on the internet.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 5

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: Mgr. Richard Cimerman, PhD.

Last change: 08.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-206/15	Seminar in Applied Meteorology (1)

Educational activities:
Type of activities: seminar
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: individual work
Final exam: final thesis
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 80/20

Learning outcomes:
By completing the seminar, the student will deepen their knowledge of atmospheric physics. They will learn to independently lecture selected parts of dynamic meteorology, atmospheric boundary layer physics, physics of clouds and precipitation.

Class syllabus:
Study, preparation and presentation of separate performances from selected topics.

Recommended literature:
The latest literature, sources from professional and scientific journals and information published on the Internet as recommended by the lecturer at the beginning of the semester

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 22

A	B	C	D	E	FX
95,45	4,55	0,0	0,0	0,0	0,0

Lecturers: RNDr. Ingrid Damborská, CSc., prof. RNDr. Milan Lapin, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-207/15	Seminar in Applied Meteorology (2)

Educational activities:
Type of activities: seminar
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4.

Educational level: II.

Prerequisites: FMFI.KAFZM/2-FOZ-206/15 - Seminar in Applied Meteorology (1)

Course requirements:
Preliminary evaluation: individual work
Final exam: final thesis
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 80/20

Learning outcomes:
By completing the seminar, the student will deepen their knowledge of atmospheric physics. They will learn to independently lecture selected parts of dynamic meteorology, atmospheric boundary layer physics, physics of clouds and precipitation.

Class syllabus:
Study, preparation and presentation of separate performances from selected topics.

Recommended literature:
The latest literature, sources from professional and scientific journals and information published on the Internet as recommended by the lecturer at the beginning of the semester.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 21

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: RNDr. Ingrid Damborská, CSc., prof. RNDr. Milan Lapin, CSc.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-171/20	Slovak Language for Foreign Students (1)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I., I.II., II., III.

Prerequisites:

Course requirements:
tests
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
This course is aimed for foreign students to learn the fundamentals of the Slovak language with the focus on basic communication as well as all other language skills- listening comprehension,reading and writing.

Class syllabus:
The sylabus is targeted at the comprehension of the basics of the Slovak language for the absolute beginners (A1).

Recommended literature:
Krížom- Krážom Slovenčina 1, additional material to further support the covered topics.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 155

A	ABS	B	C	D	E	FX	NEABS
40,65	21,29	7,1	4,52	0,65	1,29	21,29	3,23

Lecturers: Mgr. Aneta Barnes

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-172/20	Slovak Language for Foreign Students (2)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I., I.II., II., III.

Prerequisites:

Course requirements:
tests
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
This course is aimed for foreign students to learn the fundamentals of the Slovak language with the focus on basic communication as well as all other language skills- listening comprehension,reading and writing.

Class syllabus:
The sylabus is targeted at the comprehension of the basics of the Slovak language for the absolute beginners (A1) and this course is a follow up course to the Slovak language course 1.

Recommended literature:
Krížom- Krážom Slovenčina 1, additional material to further support the covered topics

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 87

A	ABS	B	C	D	E	FX	NEABS
63,22	18,39	1,15	1,15	0,0	0,0	9,2	6,9

Lecturers: Mgr. Aneta Barnes

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-271/20	Slovak Language for Foreign Students (3)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 3., 9.

Educational level: I., I.II., II., III.

Prerequisites:

Course requirements:
tests
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
This course is aimed for foreign students to better comprehend all the language skills important to enable correct usage of the Slovak language – listening comprehension, reading, writing and speaking.

Class syllabus:
The sylabus is targeted at the comprehension of all the language skills of the Slovak language , and it is a follow up course to the Slovak language course 2.

Recommended literature:
Krížom-Krážom Slovenčina 2, additional material to further support the covered topics.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 32

A	ABS	B	C	D	E	FX	NEABS
59,38	3,13	18,75	3,13	3,13	0,0	12,5	0,0

Lecturers: Mgr. Aneta Barnes

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KJP/1-MXX-272/20	Slovak Language for Foreign Students (4)

Educational activities:
Type of activities: practicals
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 4., 10.

Educational level: I., I.II., II., III.

Prerequisites:

Course requirements:
tests
Course prerequisites:
https://fmph.uniba.sk/microsites/kjp/katedra-jazykovej-pripravy/poziadavky-na-udelenie-priebezneho-hodnotenia-aj1aj2aj3-ostatne-kurzy/
Scale of assessment (preliminary/final): 100/0

Learning outcomes:
This course is aimed for foreign students to better comprehend all the language skills important to enable correct usage of the Slovak language – listening comprehension, reading, writing and speaking.

Class syllabus:
The sylabus is targeted at the comprehension of all the language skills of the Slovak language , and it is a follow up course to the Slovak language course 3.

Recommended literature:
Krížom-Krážom Slovenčina 2, additional material to further support the covered topics.

Languages necessary to complete the course:

Notes:

Past grade distribution
Total number of evaluated students: 25

A	ABS	B	C	D	E	FX	NEABS
84,0	0,0	4,0	4,0	0,0	0,0	8,0	0,0

Lecturers: Mgr. Aneta Barnes

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KEF/2-FOZ-120/22	Solar Energy and Fotovoltaics

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Prelimenary evaluation: elaboration of one presentation (20-30 min) on the chosen topic,
Final exam: written in form of test,
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
By completing the course, students will gain knowledge about overall photovoltaics, solar cells of various types, their physical principles, design and production, the use of thermal solar energy and the possibilities of solar energy storage.

Class syllabus:
Solar photons - solar radiation spectrum and its concentration, Lambert and Kirchhoff radiation law, Abbe's sine condition, Semiconductor physics - basics, band theory, electron and hole statistics, transport, scattering mechanisms of charge carriers, generation and recombination, separation, diffusion, Dember effect, surface phenomena, metal-semiconductor contact, pn junction, optical properties and photoelectric phenomena, absorption and emission, conversion of thermal radiation into chemical energy, conversion of chemical energy into electrical energy. Composition of different types of solar cells (SC) and their properties - volumetric and thin-film SC, third generation, efficiency and optimization, production technologies, Photovoltaics in practice - real applications, batteries and power electronics, solar power plants. Perspective materials and new trends in photovoltaics. Solar thermal energy - from low-temperature to high-temperature collectors, design and construction, conversion to electricity, new trends, thermal energy storage, applications. Presentation of the FMFI solar power plant. Demonstration experiments.

Recommended literature:
Úvod do fyziky pevných látek / Charles Kittel ; přeložili Miloš Matyáš [et al.]. Praha : Academia, 1985
Physics of Solar Cells/ Peter Wuerfel, Wiley-VCH, Weinheim 2005
J. Poortmans, Thin Film Solar Cells, Wiley 2007
M.A.Green, Third Generation Photovoltaics, Springer 2007

A. Goetzberger, Photovoltaic Solar Energy Genaration, Springer 2007

Languages necessary to complete the course:
Slovak in combination with English (suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 4

A	B	C	D	E	FX
50,0	50,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Tomáš Roch, Dr. techn.

Last change: 21.06.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-243/22	Solid Waste Treatment

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 10/90

Learning outcomes:
The student will gain an overview of existing conventional but also experimental technologies used for municipal solid waste disposal.

Class syllabus:
Waste characteristics. History, composition, quantity, distribution and calorific value. Waste management and management. Waste prevention, reduction and reduction. Reduction of waste sources. Waste recycling - aluminum, paper, plastics, glass, metals. Energy recovery. Waste collection, separation and treatment. OLO and ASA. Waste incineration, gasification and pyrolysis. Plasma waste disposal methods. Thermal plasma, transmitted and non-transmitted arc. Industrial installations. Composting - types of compost, factors influencing the quality of compost, methods of composting and use of compost. Landfilling - landfill classes, gases and leachates from landfills, waste solidification, landfill operation, their closure and reclamation. Waste legislation. Excursion to OLO resp. ASA

Recommended literature:
J. Pichtel: Waste Management Practices, Taylor & Francis Group (2014)
F. R. McDougall, et al.: Solid Waste Management, Wiley (2001)
M. Materazzi: Clean Energy from Waste - Plasma Process for Waste Gasification, Springer (2017)

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 9

A	B	C	D	E	FX
100,0	0,0	0,0	0,0	0,0	0,0

Lecturers: doc. RNDr. Karol Hensel, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-205/15	Solutions of Atmospheric Dynamics Equations

Educational activities:
Type of activities: lecture / practicals
Number of hours:
per week: 2 / 1 **per level/semester:** 26 / 13
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: independent work
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 20/80

Learning outcomes:
Application of numerical procedures for solving equations of atmospheric dynamics, utilization of numerical meteorological and climatological models for weather forecasting and preparation of climate change scenarios.

Class syllabus:
Scale analysis of hydrodynamic equation, geostrophic and quasi - geostrophic type of equations. Shallow water model, conservation of potential vorticity, contribution of vorticity and divergence to the solution depending on the size of the processes. Barotropic instability of atmospheric waves, structure of these waves, two-level model of baroclinic atmosphere, analysis of wave structure. Numerical methods, discrete network transition problems, minimal wave, consistency, convergence, stability, finite difference method, advection equation. Nonlinear instability and aliasing, conservation of energy in the model, The Arakawa Jacobian. Spectral methods, finite element method. Stability of schemes, adjustments and efficiency of calculation. Explicit and implicit methods. Elliptic differential equations, parabolic differential equations. Predictive and climatological models.

Recommended literature:
An introduction to dynamic meteorology / James R. Holton. New York : Academic Press, 1992
Predictability of Weather and Climate / Tim Palmer and Renate Hagedorn, Cambridge University Press 0521848822, 2006, 702pp.
Partial Differential Equations with Numerical Methods / S. Larsson and V. Thomée, Texts in Applied Mathematics 45, Springer, 2003
Numerical Weather and Climate Prediction / Thomas T. Warner, 2011. , Cambridge University Press, Cambridge, UK. ISBN: 978-0-521-51389-0. Hardback, 526 PP.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 22

A	B	C	D	E	FX
22,73	18,18	45,45	9,09	4,55	0,0

Lecturers: doc. RNDr. Martin Gera, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-115/17	Sports in Natur (1)

Educational activities:
Type of activities:
Number of hours:
per week: **per level/semester:**
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 1., 7.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Grades: A 90%, B 80%, C 70%, D 60%, E 50%
The condition for the award of 1 or 2 credits is the completion of a multi-day course in its full scope, or the completion of one-day courses in the scope of 4 days. Candidates can apply to the leaders of individual courses. From the presented offer of courses, you can choose the one that suits your interests, abilities and deadlines.

Learning outcomes:
Acquisition and development of basic motor skills and abilities in selected sports: skiing and snowboarding. Mastering the correct technique of performing individual movements, which are necessary for skiing and snowboarding.

Class syllabus:
The student can sign up for the outdoor sports courses offered by the department: skiing, snowboarding. The lessons in the courses are focused on the development of basic and special movement skills and mastering the techniques needed for the sports.

Recommended literature:

Languages necessary to complete the course:
Slovak

Notes:
KTVŠ does not rent ski equipment.

Past grade distribution
Total number of evaluated students: 186

A	B	C	D	E	FX
98,92	0,0	0,0	0,0	0,0	1,08

Lecturers: Mgr. Martin Dovičák, PhD., Mgr. Tomáš Kuchár, PhD., Mgr. Jana Leginusová, PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, PaedDr. Mikuláš Ortutay, Mgr. Júlia Raábová, PhD., Mgr. Tomáš Lovecký

Last change: 16.06.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KTV/2-MXX-116/18	Sports in Natur (2)

Educational activities:
Type of activities:
Number of hours:
per week: **per level/semester:**
Form of the course: on-site learning

Number of credits: 2

Recommended semester: 2., 8.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Grades: A 90%, B 80%, C 70%, D 60%, E 50%.
The condition for the award of 1 or 2 credits is the completion of a multi-day course in its full scope, or the completion of one-day courses in the scope of 4 days. Candidates can apply to the leaders of individual courses. From the presented offer of courses, you can choose the one that suits your interests, abilities and deadlines.

Learning outcomes:
Creating a positive and lasting relationship with physical activity. Acquisition and mastery of basic motor skills and abilities in outdoor sports: windsurfing, beach volleyball, water tourism - river rafting, hiking and other sports according to interest. Training and improving the technique needed for the sports.

Class syllabus:
The student can sign up for the outdoor sports courses offered by the department: water tourism - river rafting, windsurfing, beach volleyball, hiking and other hobby sports. The lessons in the courses are focused on the development of basic and special movement skills and, mastering the techniques needed for the sports.

Recommended literature:

Languages necessary to complete the course:
Slovak

Notes:
KTVŠ will provide sports equipment.

Past grade distribution
Total number of evaluated students: 109

A	B	C	D	E	FX
95,41	0,0	0,0	0,0	0,0	4,59

Lecturers: Mgr. Martin Dovičák, PhD., Mgr. Tomáš Kuchár, PhD., Mgr. Jana Leginusová, PaedDr. Dana Mašlejová, Mgr. Ladislav Mókus, PaedDr. Mikuláš Ortutay, Mgr. Júlia Raábová, PhD., Mgr. Tomáš Lovecký
Last change: 16.06.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-110/22	Spread of Pollutants in the Environment

Educational activities:
Type of activities: course
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
To acquaint students with the spread of pollutants in the environment, the cycle between the various spheres on Earth, current environmental problems, pollutants and their sources, environmental protection and legislation.

Class syllabus:
Structure, characteristics and significance of the atmosphere. Air composition and its changes during geological development. Mean residence time. Quasi-constant, variable and highly variable atmospheric components. Exchange times between atmospheric reservoirs. Volume and mass concentrations. Local, regional and global environmental problems. Greenhouse effect, stratospheric ozone depletion, photochemical smog, acid rain. Flow, turbulence. Vertical stratification of the atmosphere, its cases and the impact on the dispersion of pollutants. The cycle of matter between the atmosphere, the biosphere, the hydrosphere and the earth's crust. Natural processes leading to emissions of substances into the atmosphere (sea spray, radioactive decay in the earth's crust, volcanic activity, biological processes, cosmic dust). Physical and chemical transformation of substances in the air. Basic chemical reactions in the atmosphere. Dry, wet and hidden deposition. Atmospheric aerosol. Basic gaseous pollutants, PM particles, heavy metals, volatile organic compounds, persistent organic compounds. Primary and secondary air pollution and deposition limits, critical levels and loads. Air quality and its protection, legislation. Pollution sources of groundwater, lakes, rivers and seas. Spread of water pollution.

Recommended literature:
Závodský, D. – Ďurec, F. – Medveď, M., 2001: Atmospheric chemistry and air pollution modelling. UMB Banská Bystrica, 128 pp.
Unpublished teaching texts, EU and Slovak legislation in the field of environmental protection

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 50

A	B	C	D	E	FX
70,0	18,0	4,0	4,0	4,0	0,0

Lecturers: RNDr. Martin Kremler, PhD., doc. RNDr. Martin Gera, PhD.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-107/22	Synoptic Meteorology (1)

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: -
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
Students will understand the main role of synoptic meteorology, can explain the basic causes of circulation in the troposphere and with the understanding of the analyzed data thay can compile surface and upper-level synoptic maps. They will learn to recognize different types of air masses, their properties and differences on synoptic maps and aerological soundings. Students will learn to use the acquired knowledge in Synoptic Meteorology Practice (1).

Class syllabus:
History of synoptic meteorology. Basic quantities used in synoptic meteorology, display of meteorological elements on synoptic maps. Synoptic scale forces, types of horizontal flow. Analysis of input data sources, SYNOP, TEMP report and their visualization and interpretation. Use of satellites and radar measurements to identify objects of synoptic analysis. Weather forecasting methodology as a combination of current weather analysis and outputs of numerical weather prediction models. Air masses, their thermodynamic and geographical classification, transformation, identification on thermobaric maps, aerological soundings and vertical sections of quantities from numerical weather prediction models. Basics of atmospheric fronts.

Recommended literature:
Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Holton JR. 2004: An Introduction to Dynamic Meteorology, 4 ed. Elsevier Academic Press: London, UK.
K. Krška, F. Šamaj, 2001: Dějiny meteorologie v českých zemích a na Slovensku, Karolinum, 568 s.

Kolektív autorov, 1993: Meteorologický slovník výkladový a terminologický. Praha, Min. Živ. Prostředí ČR.
Pechala, F., Bednář, J., 1991: Příručka dynamické meteorologie. Academia-Ministerstvo životního prostředí ČR.
Stull, R., 2011: Meteorology for Scientists & Engineers, 3rd Edition. Univ. of British Columbia. 938 p.
Wallace, J., Hobbs, P., 2006: Atmospheric science: an introductory survey, 2nd ed. Elsevier.
Williams, J., 2009: The AMS Weather Book: The Ultimate Guide to America's Weather. Amer. Meteor. Soc., 316 pp.
Zverev, A.S, 1986: Synoptická meteorológia. Alfa, Bratislava, 712 s.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 16

A	B	C	D	E	FX
37,5	12,5	31,25	0,0	18,75	0,0

Lecturers: Mgr. Miroslav Šinger, PhD., doc. RNDr. Martin Gera, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-102/22	Synoptic Meteorology (2)

Educational activities:
Type of activities: lecture
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites: FMFI.KAFZM/2-FMK-107/22 - Synoptic Meteorology (1) and FMFI.KAFZM/2-FOZ-107/15 - Physics of Lower Atmospheric Layers

Course requirements:
Preliminary evaluation: -
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 0/100

Learning outcomes:
Students will be able to describe and identify objects of synoptic analysis on thermobaric maps - especially atmospheric fronts and pressure systems. They will learn to explain the basic physical mechanisms affecting their development, movement and typical features in various stages of development, based on which they will be able to explain the current state and changes in weather and describe the synoptic situation and its development with emphasis on central European conditions. Students will understand the interrelationships of atmospheric fronts, pressure systems and the frontal zone and the processes that affect them and the influence of other spheres of the climate system (orography, surface properties ...) on the development of the weather situation. It is a direct continuation of the lecture Synoptic Meteorology (1) and it uses the knowledge from the lecture Physics of Lower Atmospheric Layers. Students will learn to use the acquired knowledge in Synoptic Meteorology Practice (2).

Class syllabus:
The lecture consists of a basic description of conceptual models and physical processes in the troposphere on a synoptic scale with their demonstration in real situations.
Atmospheric fronts - basic quantities, classification, features on thermobaric maps, horizontal and vertical sections, slope of the frontal area, accompanying weather at the crossing of individual fronts depending on the air mass. Frontogenesis and frontolysis, diagnostics and use. Frontal zone and jet stream. Cyclones and anticyclones of mid-latitudes, their structure, properties in individual stages of development using quasi-geophrophic theory, displacement and regeneration, cyclogenesis and anticyclogenesis, rapid cyclogenesis, the relationship of the developmental phase with atmospheric

fronts and the frontal zone. Local effects, influence of orography on thermobaric fields, atmospheric fronts and pressure systems. PV method and its use.

Recommended literature:

Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Browning, K. A. and Roberts, N. M., 1994: Structure of a frontal cyclone. Q. J. R. Meteorol.Soc., 120, 1535–1557.
Buzzi, A., Davolio, S., Fantini, M., 2020: Cyclogenesis in the lee of the Alps: a review of theories. Bulletin of Atmospheric Science and Technology. 1. 1-25.
Holton JR. 2004: An Introduction to Dynamic Meteorology, 4 ed. Elsevier Academic Press: London, UK.
Hoskins, B. J., Draghici, I., Davies, H. C., 1978: A new look at the omega-equation, QJ Roy. Meteorol. Soc., 104, 31–38.
Hoskins, B. J. and Hodges, K. I., 2002: New perspectives on the Northern Hemisphere winter storm tracks. J. Atmos. Sci., 59, 1041–1061.
Markowski, P., Richardson, Y., 2010: Mesoscale meteorology in midlatitudes. Wiley-Blackwell.
McGinley, J., 1982: A Diagnosis of Alpine Lee Cyclogenesis. Mon. Wea. Rev., 110, 1271–1287.
Pechala, F., Bednář, J., 1991: Příručka dynamické meteorologie. Academia-Ministerstvo životního prostředí ČR.
Shapiro, M. A.., and D. Keyser, 1990: Fronts, jet streams and the tropopause. Extratropical Cyclones, The Erik Palmén Memorial Volume, C. W. Newton and E. O. Holopainen, Eds., Amer. Meteor. Soc., 167–191.
Schultz, D. M., Keyser, D., and Bosart, L. F., 1998: The Effect of Large-Scale Flow on Low-Level Frontal Structure and Evolution in Midlatitude Cyclones. Monthly Weather Review 126, 7, 1767-1791.
Schultz, D. M., and Vaughan, G., 2011: Occluded Fronts and the Occlusion Process: A Fresh Look at Conventional Wisdom. Bulletin of the American Meteorological Society 92, 4, 443-46.
Schultz, D. M., and Sienkiewicz, J. M., 2013: Using Frontogenesis to Identify Sting Jets in Extratropical Cyclones. Weather and Forecasting 28, 3, 603-613.
Stull, R., 2011: Meteorology for Scientists & Engineers, 3rd Edition. Univ. of British Columbia. 938 p.
Wallace, J., Hobbs, P., 2006: Atmospheric science: an introductory survey, 2nd ed. Elsevier.
Williams, J., 2009: The AMS Weather Book: The Ultimate Guide to America's Weather. Amer. Meteor. Soc., 316 pp.
Zverev, A.S, 1986: Synoptická meteorológia. Alfa, Bratislava, 712 s.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 44

A	B	C	D	E	FX
31,82	6,82	25,0	11,36	20,45	4,55

Lecturers: Mgr. Miroslav Šinger, PhD., doc. RNDr. Martin Gera, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-117/22	Synoptic Meteorology Practice (1)

Educational activities:
Type of activities: laboratory practicals
Number of hours:
per week: 3 **per level/semester:** 39
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 1.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation: activity, performance of assigned tasks
Final exam: written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
Special practice as a practical part of the course Synoptic meteorology (1). The aim of the course is to acquire skills and apply the knowledge gained in the mentioned lecture in the analysis of surface and upper-level synoptic maps, to learn to combine several parameters and use them in synoptic analysis.

Class syllabus:
Interpretation of SYNOP, TEMP messages, recognition of basic characteristics at outputs from aerological soundings / model pseudo-soundings. Analysis of sea-level pressure and pressure tendencies field on surface synoptic maps, significant weather. Analysis of upper-level maps. Identification of air masses. Current weather monitoring.

Recommended literature:
Návod k sestavování kódovaných zpráv, Vyd.ČHMÚ, Praha, 1981, 138s.
Zverev, A.S, 1986: Synoptická meteorológia. Alfa, Bratislava, 712 s.
Internet resources recommended by the teacher.

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 55

A	B	C	D	E	FX
56,36	23,64	16,36	3,64	0,0	0,0

Lecturers: Mgr. Miroslav Šinger, PhD., doc. RNDr. Martin Gera, PhD.
Last change: 15.03.2022
Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FMK-103/00	Synoptic Meteorology Practice (2)

Educational activities:
Type of activities: laboratory practicals
Number of hours:
per week: 4 **per level/semester:** 52
Form of the course: on-site learning

Number of credits: 4

Recommended semester: 2.

Educational level: II.

Prerequisites: FMFI.KAFZM/2-FMK-117/22 - Synoptic Meteorology Practice (1)

Course requirements:
Preliminary evaluation: activity, performance of assigned tasks
Final exam: written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
Special practice as a practical part of the course Synoptic meteorology (2). The aim of the course is to deepen the knowledge acquired in the lecture by applying knowledge in current situations. Students will be able to identify the properties of atmospheric fronts and air masses, properties and stages of development of pressure systems and locations of the frontal zone. Students will be able to describe the synoptic situation and estimate its probable development for weather forecasts.

Class syllabus:
Manual determination of the position and type of atmospheric fronts based on the analysis of real synoptic maps. In the second phase, the transition to the analysis of synoptic maps using numerical weather prediction models, which will allow students to combine several parameters (observation, radar and satellite measurements, outputs from numerical models) on horizontal and vertical sections of the troposphere. As a result, they will gain a more comprehensive idea of the current synoptic situation, as a result of which they will be able to better understand and interconnect the acquired theoretical knowledge. In the final phase of the course, the compilation of weather forecasts using numerical forecasting models.

Recommended literature:
Bluestein, H. B., 1993: Synoptic-Dynamic Meteorology in Midlatitudes. Vol. I, II, Oxford University Press.
Návod k sestavování kódovaných zpráv, Vyd.ČHMÚ, Praha, 1981, 138s.
Zverev, A.S, 1986: Synoptická meteorológia. Alfa, Bratislava, 712 s.
Internet resources recommended by the teacher.

Languages necessary to complete the course:

Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution
Total number of evaluated students: 78

A	B	C	D	E	FX
69,23	17,95	10,26	2,56	0,0	0,0

Lecturers: Mgr. Miroslav Šinger, PhD., doc. RNDr. Martin Gera, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FBM-151/22	Uses of Plasmas and Electric Fields in Biomedicine

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 4.

Educational level: I.II., II.

Prerequisites:

Course requirements:
Preliminary evaluation: processing of literature on selected topic and its presentation
Final exam: oral
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 30/70

Learning outcomes:
By completing the course the student will gain a comprehensive overview of the use of plasma and electric discharges, and pulsed electric fields in selected biomedical applications and therapeutic methods and an understanding of their basic principles.

Class syllabus:
Basic concepts of plasma physics, the formation of low-temperature plasma in electric discharges. Low-temperature plasma and pulsed electric fields for biological decontamination and sterilization of microorganisms (bacteria, spores, yeasts, biofilms) in air, water, surfaces, medical instruments, in living organisms. Thermal and chemical methods of disinfection/sterilization. Food spoilage prevention. Medical in-vivo, ex-vivo and in-vitro applications of plasma, plasma surgery, treatment of skin diseases, disinfection and wound healing, tooth decay and root canals. Selective induction of apoptosis and cancer treatment, cell manipulation.
Interaction of liquids with plasma and plasma activated fluids. Cell interaction with plasma, plasma activated liquids and pulsed electric field. Induced cellular and systemic processes in organisms. Importance of reactive oxygen and nitrogen forms, electroporation and electropermabilization of cell membranes. Bio-compatible and antimicrobial plasma surface treatment.

Recommended literature:
· M. Laroussi et al. (eds.): Plasma medicine: applications of low-temperature gas plasmas in medicine and biology. Cambridge University Press, 2012
· A. Fridman and G. Friedman: Plasma medicine, Wiley 2013
· Z. Machala; K. Hensel; Y. Akishev (Eds.): Plasma for Bio-Decontamination, Medicine and Food Security, NATO Science for Peace and Security Series A: Chemistry and Biology, Springer 2012

· H-R. Metelmann, T. von Woedtke, K-D. Weltmann: Comprehensive Clinical Plasma Medicine, Springer 2018
Electronic texts available on the subject website

Languages necessary to complete the course:
Slovak in combination with English (some of the suggested readings are in English).

Notes:

Past grade distribution
Total number of evaluated students: 2

A	B	C	D	E	FX
50,0	50,0	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc.

Last change: 14.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.

COURSE DESCRIPTION

Academic year: 2026/2027

University: Comenius University Bratislava

Faculty: Faculty of Mathematics, Physics and Informatics

Course ID:	**Course title:**
FMFI.KAFZM/2-FOZ-214/22	Water Pollution Control

Educational activities:
Type of activities: lecture
Number of hours:
per week: 2 **per level/semester:** 26
Form of the course: on-site learning

Number of credits: 3

Recommended semester: 3.

Educational level: II.

Prerequisites:

Course requirements:
Preliminary evaluation:
Final exam: oral / written
Indicative evaluation scale: A 90%, B 80%, C 70%, D 60%, E 50%
Scale of assessment (preliminary/final): 10/90

Learning outcomes:
The student will gain an overview of existing conventional and innovative experimental technologies used for water purification and treatment.

Class syllabus:
Drinking, utility and operating water and wastewater - characteristics and basic properties. Composition, sources and quality of water, legislation and rules for quality control.
Water purification and treatment technologies and their principles. Mechanical processes - quantity and quality balancing, sieves, sedimentation, filtration, flotation. Physical processes - adsorption, ion exchange, reverse osmosis, distillation, degassing. Chemical processes - neutralization, precipitation, coagulation, extraction, oxidation and reduction, chlorination, combustion. Biological processes - natural, biofilters, activated sludge, anaerobic processes, denitrification. Wastewater treatment plant.
Advanced oxidation processes - UV photolysis, oxidation by O3 and H2O2, photocatalysis, wet oxidation, water radiolysis. Ozone generation - UV radiation, radiochemistry, electrolysis, electric discharges in gases. Ozone formation kinetics in gases. Technical aspects and future of ozonation. Commercial and industrial equipment - drinking and utility water, wine industry, swimming pools, cooling towers, food processing, aquaculture. UV radiation - sources (lamps, LED, excimer), its biological and germicidal effects. Electron beam. Electric discharges in water, above the water surface, discharges in bubbles. Discharge formation in water and chemical processes induced by the discharge. Decomposition of aromatic hydrocarbons, organic dyes and decolorization. Influence of catalysts. Oxidation in supercritical water.
Chemical and biological analysis of water. A brief overview of analytical methods for the analysis of chemical composition and water quality.
Excursion to the wastewater treatment plant.

Recommended literature:

E. Chmielewská: Čistenie a úprava vôd, skriptá PriF UK, Bratislava (1995)
D. L. Russell: Pactical wastewater treatment, Wiley (20006)
A.D. Patwardhan: Industrial waste water treatment, PHI Publisher (2008)
V. I. Parvulescu, et al.: Plasma chemistry and catalysis in gases and liquids, Wiley (2012)

Languages necessary to complete the course:

Slovak in combination with English (some of the suggested readings are in English)

Notes:

Past grade distribution

Total number of evaluated students: 9

A	B	C	D	E	FX
88,89	11,11	0,0	0,0	0,0	0,0

Lecturers: prof. RNDr. Zdenko Machala, DrSc., doc. RNDr. Karol Hensel, PhD.

Last change: 15.03.2022

Approved by: prof. RNDr. Zdenko Machala, DrSc.