Courses taught in foreign languages in academic year 2024/25

CONTENT

* individually offered course

DEPARTMENT OF BIOLOGY + CENAB

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Application of Methods of Molecular Genetics in Studies of Microbial Communities***
Course code:	KBI/E128
ECTS:	7
Level of course:	Master
Teacher:	Milan Gryndler
Term:	Summer
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	Exam
Course goal:	Microbial communities (in soil, in sediments, in composts, etc.) often show high taxonomic diversity and can be studied using various cultivation or molecular methods. The problem connected with application of cultivation methods consists in strong preference for detection of easily culturable microorganisms, while slow growing ones, or those producing small amounts of propagules, are not efficiently detected and unculturable organisms cannot be detected at all. Molecular detection methods are independent on culturability of microorganisms because they detect DNA from different microbial taxa. The course will provide the basic training in most common molecular methods. Their advantages and limitations will be discussed, and practical application protocols will be given.
Abstract:	1) Introduction: good laboratory practice in molecular genetics, designing the experiments 2) Laboratory exercise 1 - Good laboratory practice 3) Extraction and purification of DNA from microbial cultures (theory), polymerase chain reaction (PCR) use in molecular genetic detection methods (theory), selective DNA primers 4) Laboratory exercise 2 - Extraction and purification of environmental and microbial DNA, PCR 5) Purification of the PCR products, gel electrophoresis, restriction cleavage (theory), gradient gel electrophoresis DGGE and TGGE 6) Laboratory exercise 3 - Purification of the PCR products, gel electrophoresis 7) Methods of the amplicon analysis: RFLP, T-RFLP, RAPD. Ligation of DNA fragments, AFLP 8) Laboratory exercise 4 - Restriction analysis 9) DNA sequencing: Sanger sequencing and high-throughput sequencing methods. The use of sequencing methods in the identification of microorganisms 10) Analysis of sequencing data in microbial ecology 11) Molecular cloning, cloning vectors, heterologous gene expression, and expression vectors for E. coli and yeasts. 12) Examples of molecular genetic analysis of microbial communities I. 13) Examples of molecular genetic analysis of microbial communities II.

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Behavior***
Course code:	KBI/E127
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Eva Jozífková
Term:	Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation per week
Completion:	Exam
Course goal:	Students will get an introduction to Ethology, Behavioral Ecology, and Sociobiology. The chapters containing Human Ethology, and Evolutionary Psychology are also included. Basic terms, and principles connected to the behavior at these fields of study with examples explaining both animal and human behavior are given.
Abstract:	1. The roots of ethology, behavioral ecology and sociobiology Tinbergen´s four questions, ultimative and proximative causation 2. Adaptation, fitness, fitness cost x benefits, strategy, tactics, heredity of behaviour, altruism 3. Ethology: Lorenz, Tinbergen, von Frisch, ethology terms 4. Neural x humoral regulation, decision making, aggression 5. Social behaviour, hierarchy, 6. Social systems, mating systems 7. Sexual behavior, alternative reproduction strategy parent-parent conflict 8. Parental behaviour, parental investment, parent-offspring conflict, offspring – offspring conflict, helpers, infanticide, sex ratio 9. Maintenance behavior I. 10. Maintenance behavior II. 11. Signals and communication 12. Ontogeny, play, learning, memory, nurture versus nature, personality 13. Normality and “abnormal behaviour”, human ethology 14. Evolutionary psychology
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Biophysics***
Course code:	KBI/E126
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Dominika Wrobel, Dana Gášková
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation + 1 exercise per week
Completion:	Exam
Course goal:	This course is an introduction to biophysics examining main topics in this broad area. The course will cover a wide range of topics, applying physical principles and techniques to different problems in biology.
Abstract:	1) Order in an entropy-driven world 2) Molecular building blocks of life 3) Molecular interactions and forces in biology 4) Macromolecular conformation 5) Random walks, diffusion, friction and dissipation 6) Thermodynamics of biosystem 7) Chemical forces and molecular self-assembly
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Plant Biotechnology***
Course code:	KBI/E125
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Hana Auer Malinská
Term:	Winter
Language of instruction:	English
Lectures/exercises:	1 individual consultation + 1 exercise per week
Completion:	Exam
Course goal:	Students will get a theoretical and practical introduction to important methods and techniques in biotechnology. Work with different biological systems will be emphasised. Organisation of the laboratory work and combining the use of different methods for analysis of specific issues will be important. Safety in the laboratory environment will also be covered.
Abstract:	1) DNA technologies 1.1 DNA manipulation in bacteria, plants, animals and humans - molecular cloning 1.2 Gene editing and beyond 1.3 Basics of Bioinformatics 2) RNA technologies 3) In vitro technologies 3.1 Plant cell cultures 4) In vivo technologies 4.1 Plant models - phytoremediation
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Ecology***
Course code:	KBI/E107
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Michaela Czerneková
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation per week
Completion:	Exam
Course goal:	The ecology is the science of the interactions among living organisms and their environment. This subject is concentrated on the characteristics of the environment of living organisms, ecological factors (abiotics x biotics). The ecology of populations, synecology, aquatic and landscape ecology are the major subjects of these lectures. Other topics include the study of biodiversity, ecosystem, other parts of the biosphere and the relationship between man and the biosphere.
Abstract:	1. Introduction to the ecology, syllabus and recommended literature 2. Terminology, definition of ecology, biotic and abiotic environment, classification of factors, field and subject of ecology 3. Organism and his environment, adaptation, divergence and convergence, nomenclature and terminology 4. Ecological factors (abiotics x biotics), climate and clime, classification and characteristics of biomes 5. Territory such as source, special forms of nutrition 6. Ecological characteristic of atmosphere, hydrosphere and pedosphere 7. Interactions among living organisms and their environment, characteristics of the environment of living organisms 8. The ecology of populations, density, distribution, structure, natality and mortality, migration, population dynamics 9. The ecology of guilds, synecology, density, abundance, production, dominance, presence and absence, other characteristic 10. Interspecific and intraspecific interactions among living organisms 11. The study of ecosystem, other parts of the biosphere and the relationship between man and the biosphere 12. The study of biodiversity, diversity index 13. Discussion and conclusion

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Genetics***
Course code:	KBI/E124
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Regina Herma
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation + 1 exercise per week
Completion:	Exam
Course goal:	The goal of this course is to provide students with an overview of the principles of plant and animal genetics including Mendelian and modern concepts of heredity. Developments in molecular genetics will be addressed through the chemistry and physiology of the gene and the nature of gene action in prokaryotic and eukaryotic cells.
Abstract:	Introduction to genetics Mitosis and Meiosis Mendelian Genetics: Monohybrid crosses, Dihybrid and Trihybrid crosses Sex Determination and Sex Linkage Gene Interactions Sex, Genes and the Environment Pedigrees and Probabilities, Quantitative Traits, Genetic Testing, Quantitative Genetics Linkage and Genetic Maps Bacterial Genetics DNA Structure, Replication, Gene Expression Control of Gene Expression in Prokaryotes/Eukaryotes PCR and DNA cloning, Blotting and Probing, Applications of Recombinant DNA Technology RNA Viruses and Transposable Elements Chromosomal Mutations: Changes in Structure, Altered Chromosome Number DNA Mutations Mitochondrial DNA Population and Evolutionary Genetics Practical part: Cultivation of bacteria, transformation, isolation of plasmid DNA, PCR, analysis of sequencing results, database searches, general microscopy techniques, cultivation of prokaryotic/eukaryotic cells, transfer of DNA to cells and analysis of gene expressions.

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Molecular Biology***
Course code:	KBI/E111
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Olga Janoušková
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation + 1 exercise per week
Completion:	Exam
Course goal:	The main goal of this course is to introduce students into molecular basis of life. Students will learn about synthesis and transformation of biomolecules within the cell. About the connection between the structure of the molecule and its function in living cells.
Abstract:	1) Molecular genetics of the cell: Structure, function and synthesis of nucleic acids. Cell biology central dogma about the information flow in the cell. Structure of the genome. Concept of the gene and gene structure. DNA replication and repair. Genetic recombination. Transcription and translation and their regulation. Basic recombinant DNA techniques.
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Mycology***
Course code:	KBI/E112
ECTS:	7
Level of course:	Master
Teacher:	Milan Gryndler
Term:	Summer
Language of instruction:	English
Lectures/exercises:	2/0 per week
Completion:	Exam
Course goal:	Status of Fungi and fungus-like members of Protozoa and Chromista. General characteristics incl. morphology, biology and phylogeny of these groups are given. The basic terminology is explained and a new literature on this field is demonstrated. The systematic treatment of main groups (phyla/divisions, classes, orders and their representatives), their ecology and significance in phytopathology, medicine, health service or biotechnology is given. The theoretical knowledge by practical training is supplemented.
Abstract:	Fungi will be introduced as a group of organisms with great ecological importance. A delimitation and basic characterization of this group will be provided, including various aspects of morphology, physiology, ecology and phylogenesis. Basic methods of laboratory manipulation with fungi will be mentioned. Contents: 1. General characteristics of fungi as a biological group. Fungi and the history of mankind 2. Classification of fungi 3. Morphology, growth and reproduction of fungi 4. Cultivation of edible fungi 5. Fungal nutrition, metabolism and biomass composition 6. Communication of the fungal cell with the environment 7. Fungi in nature. Diversity and dispersal 8. Medicinal use of fungi 9. Anaerobic fungi 10. Fungal antibiotics penicillin and mucidin. Fungal toxins 11. Pathogenic fungi 12. Arbuscular mycorrhizal symbiosis 13. Orchideoid and ericoid mycorrhizal symbiosis 14. Ectomycorrhizal symbiosis 15. Symbiosis of fungi with animals

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***General of Parasitology***
Course code:	KBI/E104
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Michaela Liegertová
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation per week
Completion:	exam
Course goal:	The parasitology belongs into the important biological fields. These lectures are concentrated on the general characteristic of parasites, parasitology as field, parasite-host interactions and their biology and ecology. There is also includes the basic systematic classification of parasites and characteristic of the main taxonomic groups (protozoans, helminths and parasitic arthropods), special parts are applied to the most important diseases caused by parasites (toxoplasmosis, malaria, encephalitidis, etc.).
Abstract:	1. Introduction to parasitology, syllabus and recommended literature 2. The general parasitology - part I (terminology, definition of parasites, hosts and environment, classification of parasites) 3. The general parasitology - part II (life cycles, immunology, parasites and immunity) 4. Protozoology I (characteristic of protozoans, trypanosomosis, leishmaniosis) 5. Protozoology II (trichomoniasis, giardiosis, amoebiasis) 6. Protozoology III (coccidiosis, toxoplasmosis, malaria, balantidiosis) 7. Helminthology I (characteristic of helminths, intestinal trematode) 8. Helminthology II (fasciolosis, dicrocoeliosis, paragonimosis, intestinal cestoid, taeniae) 9. Helminthology III (hymenolepiosis, nematode worms, trichuriosis) 10. Helminthology IV (trichinellosis, ascariosis, enterobiosis, tropical filariosis) 11. Arachnoenthomology I (characteristic of parasitic arthropods and acarid) 12. Arachnoenthomology II (parasitic insects, lice, kissing bug, dipterous, chigger and flea) 13. Discussion and conclusion
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Plant Physiology***
Course code:	KBI/E103
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Hana Auer Malinská
Term:	Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation + 1 exercise per week
Completion:	Exam
Course goal:	The main goal of this subject is to introduce students in the basic principles of plant physiology. An attention will be paid to the connection of plant morphology, physiology, the function of individual types of plant tissues, the molecular biology background of processes in plant cell and molecular base of the most important physiological processes in plants. The course has two forms - theoretical as well as practical. During the practical part, students will be trained in the basic methods of plant physiological studies.
Abstract:	1. Basic structure and function of the plant cell 2. Elementary composition and metabolism of plant cell 3. Water regime of plants 4. Mineral nutrition of plants 5. Photosynthesis - primary processes 6. Photosynthesis - secondary processes 7. Respiration of plants 8. Transport of assimilates. Heterotrophic nutrition of plants 9. Growth and development of plants - growth regulators 10. External factors of plant growth and plant development 11. Physiology of seed germination, flower, fruit, seed and tuber development 12. Dormancy and senescence of plants. Plant movement. 13. Plant tissue cultures 14. Physiology of plant stress 15. Genetic determination of physiological process
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Microsystems in Biology and Medicine***
Course code:	KBI/E122
ECTS:	7
Level of course:	Bachelor/ Master
Teacher:	Marcel Štofik
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation per 2 weeks / 2 six-hour sessions of laboratory exercise
Completion:	Exam
Course goal:	The goal of the course is to provide an overview of the field of microsystems in biology and medical sciences. Students will get to know the current approaches to fabrication of microsystems for bioapplications and have a basic knowledge of the principles in the field of biosensors and microfluidics. Main bioapplications will be reviewed.
Abstract:	The main topics of the course: 1) An introduction into microsystems in biology and medicine (BioMEMS, uTAS, LOC). 2) Microfabrication techniques of microdevices – materials for microfabrication, patterning and biopatterning, hard and soft microfabrication techniques. 3) Biosensors and their basic principles. 4) An introduction into microfluidics for biology. 5) Microsystems in bioapplications part I – sample treatment (approaches in sample preparation, separation and analysis), microfluidic PCR, microarrays, microfluidic immunoassays, LFIA systems. 6) Microsystems in bioapplications part II – cells on chip (cells cultivation, cells studies on chip, cells sorting, separation and capture on chip), microsystems for tissue engineering (tissues and organs-on-chip), microsystems for animal and plant model studies, Point of care systems, implantable microdevices.
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Animal and Human Physiology***
Course code:	KBI/E106
ECTS:	7
Level of course:	bachelor/master
Teacher:	Stanislav Vinopal, Marian Rupert
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2 lectures / 3 exercises per week
Completion:	Exam
Course goal:	The aim is to provide information on function of organs and their systems in various animal species and man with special attention to the integrative role of the nervous, endocrine and immune systems. Each lecture session is followed by practical exercise of organ functions using self-monitoring, simple didactic tools, instrumentation, interactive and simulation PC programs including Virtual Physiology (SimNeuron, SimNerv, SimMuscle, SimHeart, SimVessel), Strathclyde Pharmacology Simulations and Neurolab. Exercises include anatomical models of human organs, fixed small animal organs including in situ organ preparations and microscopic preparations.
Abstract:	1. The internal environment (IE) of the organism and regulation of its physical, chemical and biological stability (homeostasis). 2. Excitability of animal cells. (i) Membrane potential, action potential and its conduction through the axon. Synaptic transmission and types of neurotransmitters. (ii) Types and functions of receptors. Receptor and generator potentials, (iii) Reflexes, their types, pathways and functional manifestations. 3. Types of nervous systems (NS) of animals. Functions of the peripheral NS, spinal cord, brain stem and terminal brain. Special sensory organs and cortical analysers. 4. Autonomic nervous system (ANS). Functional morphology of the ANS. Control of motility, secretion, internal organs and homeostasis of the internal environment by the peripheral part of the ANS and brain centers. 5. Higher brain functions. Instincts, drives, learning, memory, emotions, sleep and behavior. 6. Movement and its control. Muscular and non-muscular mechanisms of movement. Functional morphology of myocytes. Motor unit. Types of muscle contraction. Functions of major muscle groups. Neuromuscular junction. Reflex and voluntary motor movements and their neural pathways. 7. Hormones and their integrative role in the body. (i) Definition, classification of hormones and their organ and cellular sources. Receptor reception and transmission of hormonal signals in cells and in the body. Feedback regulatory mechanisms. Functions of hormones in metabolism, growth and reproduction. Growth factors. (ii) Stress and the stress-response. Phylogeny of endocrine regulation. 8. Circulation of body fluids, their chemical composition and compartmentalization. Open and closed circulatory systems. Neurogenic and myogenic types of hearts. Vertebrate cardiac cycle, blood pressure regulation. Composition and function of blood in vertebrates, including human. 9. Immunity, its meaning and forms. Specific humoral and cell-mediated immune responses in mammals, including human. Immunity disorders (AIDS, allergies, autoimmune diseases, anti-tumour immunity). Transplantation reactions. 10. Metabolism of substances and energy. (i) Caloric and biological value of food. Basal metabolism. Intermediary metabolism (ii) Transport of gases in the body and

	its chemical and neural regulation. Energy metabolism, including oxidative phosphorylation, (iii) Nervous and humoral regulation of respiration. (iv) Metabolic residues and their excretion. 11. Food intake and processing. Functional anatomy of the gastrointestinal system of animals, including human. (i) Uptake, digestion and absorption of nutrients. (ii) Nervous and humoral regulation of motility, secretion of the gastrointestinal tract and associated organs. Feeding behaviour of animals and its metabolic and neural regulation. 12. Functions of the integument. Thermoregulation and its control. Biorhythms, their significance and regulation. 13. Reproduction. Functions of the sexual organs. Formation of gametes. Nervous, humoral and social regulation of reproduction. Sociobiological and phylogenetic aspects of animal and human reproduction.
Requirements on student/Prerequisites	General Zoology, Molecular Biology, Introduction to Chemistry and Biochemistry

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Wildlife management***
Course code:	KBI/E130
ECTS:	7
Level of course:	Master
Teacher:	Markéta Gloneková
Term:	Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation per week
Completion:	Exam
Course goal:	This course will introduce the principles of animal conservation biology in situ (in the natural habitat of the species) and ex situ (out of the natural habitat – zoo). Students will learn to compile the wildlife management plan of their choice. The course will include an excursion to the zoo.
Abstract:	Main topics: 1. Habitat assessment and biodiversity value 2. Methods in animal ethology and ecology 3. Conservation programs (in-situ protection) 4. Population dynamics 5. Ecotourism 6. Environmental education 7. Population management 8. Principles of ranch and farm breeding 9. Hunting and trade 10. The role of zoos (ex-situ protection) 11. The wildlife management plan
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Science education***
Course code:	KBI/E131
ECTS:	7
Level of course:	Master
Teacher:	Kateřina Jančaříková
Term:	Winter/Summer
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	Exam
Course goal:	Students will get acquainted in an interactive form with the theory and practice of modern science education with an emphasis on biology education and STEM education.
Abstract:	1. Introduction to the subject. Objectives of science education. Nature as an object of interest. 2. Developmental theories and science education (Jean Piaget, Lev S. Vygotskij, thinking and speech). Pedagogical applications of knowledge of developmental theories. 3. Intelligence theory. Howard Gardner's naturalist intelligence. Science gifted pupils in the school. 4. Science literacy. 5. Pedagogical Theories (behaviorism, structuralism, theory of didactic situations, connectivism) of and their influence on science education. 6. Science language. Nonverbal Communication. 7. Method of "good" questions. 8. Didactic principles of Science education. 9. Teaching aids and their classification. Real objects and living organisms. Representations (models, displays, projections, books). Multisensory aids. Games and gamification. Programs, teaching automats, applications. Measuring instruments. 10. Proven didactic approaches for science education ie. heuristic methods, research method, narrative method, place - based education, outdoor learning, transformative learning. 11. Theory of Didactics Situation by Brousseau. 12. Summary, reflection.
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***School Natural Garden***
Course code:	KBI/E132
ECTS:	7
Level of course:	Master
Teacher:	Kateřina Jančaříková
Term:	Summer
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	Exam
Course goal:	Students will get acquainted with the movement for school natural gardens and with the possibilities that the use of school gardens offers for the teaching of science subjects (not only). The course follows the course Ecology and Science Education. An important part of the course is getting acquainted with the natural garden on the campus and activities on it.
Abstract:	1. Introduction to the issue. Structure and function of controlled ecosystems (agroecosystems) including interactions of internal biotic and external socio-economic processes on the model example "natural school garden". Agroecosystem - agroecosystem X natural ecosystem, basic concepts (additional energy, cycles of substances, habitats, ecological niches, biomass, etc.). 2. Garden as a model agroecosystem. History of school gardens. Eubiotic movement. School gardens as natural classrooms and places of relaxation in the Czech Republic and the world. Outdoor lessons. Orchard schools. Forest nurseries. Garden therapy. 3. Natural gardens and their characteristics. How to certify a natural garden in Czech republic. Permaculture. Stone gardens. Vertical gardens. Mossy painting. 4. Habitats, habitats, game and educational elements, model organisms in the school garden. 5. Four elements in the school garden. Garden for spontaneous and creative activities of students. 6. Competencies that can be developed in the school garden. 7. “Good” question in the school garden. 8. Research activities in the school garden. 9. Production from natural materials in the school garden. 10. Community planning of school gardens. 11. Special elements in the school garden (eg apiary). 12. Summary, reflection.
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Animal and Plant Models in Biology***
Course code:	KBI/E123
ECTS:	10
Level of course:	Bachelor/Master
Teacher:	Hana Auer Malinská, Dominika Wrobel, Michaela Czerneková, Michaela Liegertová
Term:	Winter or Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation/ 1 exercise per week
Completion:	Exam
Course goal:	In this specialized course, the students will get a practical introduction into basic in vitro and in vivo experimental techniques in biology. These include work with plant and animal/human cell cultures (2D/3D) as well as experimental work with living organisms (plants, invertebrates, vertebrates). Particular emphasis will be laid on the design and planning of experimental work, documentation, critical evaluation including qualitative and quantitative analysis of the results, as well as laboratory safety and ethical aspects.
Abstract:	Each of the topics usually involves 1 week of theoretical preparation and 1 week of practical laboratory experiment. Topics: 1) Good laboratory practice - Safety rules and regulations 2) in vitro cell cultures – plants Nicotiana tabacum, Solanum tuberosum, Daucus carota), plant cultures, callus cultures, suspension cultures 3) in vitro cell cultures – animals/human (mammalian cell and human carcinoma cell lines) 4) in vivo models – plants (Nicotiana tabacum, Miscanthus x giganteus, model for phytoremediation, stress physiology), Pisum sativum -salinity stress testing 5) in vivo models – invertebrates (Tardigrades as an emerging model for cryptobiosis, pharmaceutics and cellular biology) 6) in vivo models – vertebrates (Danio rerio - toxicity testing, xenotransplantation, animal welfare and legal issues)
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Laboratory Techniques in Molecular and Cell Biology***
Course code:	KBI/E121
ECTS:	10
Level of course:	Bachelor/Master
Teacher:	Michaela Liegertová, Lukáš Bystrianský/Milan Gryndler, Stanislav Vinopal, Dominika Wrobel, Regina Herma, Alena Semerádtová
Term:	Winter or Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation/ 1 exercise per week
Completion:	Exam
Course goal:	In this specialized course, the students will get a theoretical and practical introduction to a set of selected important methods and techniques in molecular and cell biology. Furthermore, particular emphasis will be laid on the design and planning of experimental work, documentation, critical evaluation including qualitative and quantitative analysis of the results, as well as laboratory safety aspects.
Abstract:	Each of the topics usually involves 1 week of theoretical preparation and 1 week of practical laboratory experiment. Topics: 1) Good laboratory practice - Safety rules and regulations 2) Molecular Cloning + Bioinformatics 3) Flow Cytometry 4) Cell Sorting 5) Quantitative PCR 6) Plate Reader Assays
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Microscopy Techniques in Biology***
Course code:	KBI/E120
ECTS:	10
Level of course:	Bachelor + Master
Teacher:	Regina Herma, Marcel Štofik, Stanislav Vinopal, David Poustka, Oldřich Benada, Alena Semerádtová
Term:	Winter or Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation/ 1 exercise per week
Completion:	Exam
Course goal:	This specialised course will provide the students with hands-on-experience in various microscopy techniques and instrumentation. The students will learn the basic hardware/software working principles as well as different sample preparation methods. Emphasis will be laid on the design and planning of experimental work, documentation, critical evaluation including qualitative and quantitative analysis of the results, as well as laboratory safety aspects.
Abstract:	Each of the topics usually involves 1 week of theoretical preparation and 1 week of practical laboratory experiment. Topics: 1) Good laboratory practice - Safety rules and regulations 2) Light and Fluorescent Microscopy 3) Confocal microscopy 4) Electron microscopy SEM 5) Electron Microscopy TEM 6) AFM
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology + CENAB**
Course title:	***Design and Rapid Prototyping of Microsystems in Biology and Medicine***
Course code:	KBI/E119
ECTS:	10
Level of course:	Bachelor + Master
Teacher:	Marcel Štofik, Jiří Smejkal, Petr Aubrecht, Petr Panuška, David Poustka
Term:	Winter or Summer
Language of instruction:	English
Lectures/exercises:	1 individual consultation/ 1 exercise per week
Completion:	Exam
Course goal:	This practical course provides the basic insight into the technological cycle of microdevices fabrication for the field of biology and medicine. During the course, the planning and designing of the microsystems will be examined. Selected rapid prototyping techniques will be presented. Students will examine how to work with 3D printing technologies, with selected micropatterning technologies photolithography, laser lithography, soft lithography or µcontact printing). Also sandblasting technology will be presented. Based on the local technical background for microsystems fabrication, students will plan and fabricate their own microsystem under professional guidance. The fabricated microsystems will be tested for its functionality.
Abstract:	Each of the topics usually involves 1 week of theoretical preparation and 1 week of practical laboratory experiment. Topics: 1) Good laboratory practice - Safety rules and regulations 2) 3D CAD designing 3) 3D printing by FDM and DLP technique 4) UV and Soft lithography 5) Microblasting technology 6) Microfluidics devices
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Biology/ ZOO Ústí nad Labem/ ZOO Liberec**
Course title:	***Welfare Assessment of zoo animals in practice***
Course code:	KBI/E133
ECTS:	10
Level of course:	Bachelor/Master
Teacher:	Markéta Gloneková, Petra Padalíková, Ilona Pšenková, Dorota Gremlicová
Term:	Winter or Summer
Language of instruction:	English
Lectures/exercises:	First week: individual consultations and home preparation Second week: Practical course in the zoo
Completion:	Exam
Course goal:	This specialised course will introduce students to the zoo in practice. In the first week they will theoretically learn how the zoo works, what EAZA means, they will go through the management guidelines for the species, learn about enrichment of zoo animals, find out what the welfare assessment means and how it could be analysed. In the second week the students will use the mentioned knowledge in practice. They will try to work in the zoo and compile the welfare assessment for several species.
Abstract:	Topics: The role of a modern zoo European Association of Zoos and Aquaria – EAZA IUCN Red List of Threatened Species Zoo animals breeding management Reintroduction Enrichment Welfare Assessment
Requirements on student/Prerequisites	

DEPARTMENT OF PHYSICS

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Atomic and Nuclear Physics***
Course code:	KFY / E511
ECTS:	10
Level of course:	bachelor
Teacher:	doc. RNDr. Anna Macková, Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	3/2 per week
Completion:	credit, exam
Course goal:	In the frame of the course will be explained the basic concepts of atomic and nuclear physics. We begin with description of atomic models as were developed in accordance to the important experiments accomplished at the beginning of 20th century. Thomson's experiment, discovery of electron, Rutherford experiment leading to the hypothesis of atomic nuclei, the observation of optical spectral lines during study of discharges in gases will be discussed. The study of spectral lines led to the Bohr atom model and to the birth of quantum mechanics itself. The atomic orbital model provided a new theoretical basis for spectroscopy. Main experiments leading to quantum theory introduction will be studied and commented in the frame of classical and quantum physics differences: photoelectric effect and its Einstein's interpretation, Compton's effect and wave-particle duality of particles, Davison-Germer experiment, Planck’s interpretation of black-body radiation. Basic ideas and concepts of quantum mechanics will be presented and applied in the frame of quantum-mechanic model of hydrogen atom. Schrödinger equation for hydrogen atom will be solved and then we discuss the meaning of the hydrogen atom wave functions and energies. In the frame of atomic shell structure will be looked through the Frank-Hertz experiment, angular momentum of electron, spin of electron, magnetic behavior of atoms, atomic shell structure in accordance with periodic table of elements. The basic information about the origin, main principles and experimental data connected with atomic optical spectra will be presented and followed by discussion about the basic rules adopted for electromagnetic transition probability. Basic X-ray emission mechanism will be described and X-ray application in material science and medicine will be briefly introduced. The concept of electron spin will be shown on experiments leading to the electron spin discovery (Stern-Gerlach experiments with atomic beam in non-homogeneous magnetic field, Einstein-de Haas experiment dealing with macroscopic magnetic momentum measurement). Spin-orbital coupling of electrons causing fine structure of electronic levels in atoms will be discussed. In the second part of course we will focus on nuclear physics – firstly discovery of proton and neutron and first atomic nuclei models will be introduced. Basic physical quantitities as nuclei mass, binding energy as a function of nucleon number will be presented. Natural radioactivity, radioactivity decay rules, conservation laws and types will be described - production of alpha, beta and gamma particles. Cosmic rays origin and physical properties will be presented. Nuclear reactions,

	types of nuclear radiation, conservation laws and cross sections of these processes in accordance with the type of interaction (strong, weak, electromagnetic interaction) will be mentioned. We will touch the following topics - nuclear models, neutrons and protons in nuclei and their characteristics, basic characteristics of other particles, different types of nuclear reactions, fission and its application in nuclear reactors, detectors of ionizing radiation, main principles of detection of neutral and charged particles.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Thermodynamics and Statistical Physics***
Course code:	KFY / E369
ECTS:	10
Level of course:	master
Teacher:	doc. RNDr. Filip Moučka, Ph.D., doc. RNDr. Michal Varady, Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	3/1 per week
Completion:	credit, exam
Course goal:	Theoretical introduction into the equilibrium thermodynamics and statistical physics for students of physics and teachers of physics.
Abstract:	Basic principles of Thermodynamics. Entropy. Thermodynamic potentials. Open systems. Phase equilibrium and transitions. Low Temperatures. Ideas and principles of statistical physics: thermodynamic vs. mechanical properties, statistical description, statistical ensemble and distribution, ergodicity, quantum vs. classical mechanical description. Microcanonical ensemble: Liouville's thorem, microcanonical distribution, number of microscopic states. Canonical ensemble: Boltzmann's distribution, canonical partition function, thermodynamic properties in canonical ensembles. Quasiclassical approximation: equipartition theorem, Maxwell-Boltzmann's distribution, Barometric formula. Classical ideal gas: classical approximation, de Broglie wavelength, contributions to canonical partition function and thermodynamic properties: translational, rotational, vibrational, electronic. Heat capacity. Ideal crystal: Classical, Einstein and Debye models, partition functions and heat capacity. Quantum ideal gasses: Bose-Einstein and Fermi-Dirac statistics, blackbody radiation. Interacting systems: molecular models, interaction energy and potentials, virial equation for gasses, the second virial coefficient. Numerical methods in statistical physics: Monte Carlo, Metropolis algorithm, molecular simulation.
Literature:	Pippard, A.B.: Elements of Classical Thermodynamics, Cambridge Univ. Press, 1964 Fermi, E.: Thermodynamics, Dover Publications, Inc., New York, 1936 Mandl, F.: Statistical Physics, John Willey and Sons, 2002 Reif, F.: Fundamentals of Statistical and Thermal Physics, McGraw-Hill Series in Fundamentals of Physics, 1965

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Solid State Physics***
Course code:	KFY / E861
ECTS:	5
Level of course:	bachelor
Teacher:	Mgr. Jindřich Matoušek, Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	2/1 per week
Completion:	credit, exam
Course goal:	Structure of solids, basic principles of experimental techniques of structure determination. Crystal lattice, oscillations of crystal lattice, specific heats. Crystalline defects, stiffness of crystals. Electrical properties of solids. Basics of the band theory of solids. Classification of matters based on electric conductivity. Electrons in periodic potential. Intrinsic and extrinsic semiconductors and their applications. Transport phenomena in solids. Magnetic properties of solids. Superconductivity.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***An Introduction to Quantum Physics***
Course code:	KFY / E530
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Stanislav Pařez, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	3/1 per week
Completion:	credit, exam
Course goal:	The lecture is the first part of the course, which is aimed at an understanding the fundamentals of quantum mechanics (QM) and its importance in the modern physics. Theoretical and experimental starting points of QM. The mathematical introduction. The postulates of QM - a general discussion. Schrödinger equation. The measurement in QM. The uncertainty relations. The relations of QM to the classical mechanics (the classical limits). Simple problem in one dimension (the free particle, the single-step potential, the continuity equation for probability, the quantum tunnelling, the particle in a potential box). The harmonic oscillator. The angular momentum (the eigenvalue problem of L^2 and L_z).

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Quantum Physics***
Course code:	KFY / E737
ECTS:	5
Level of course:	Master
Teacher:	Mgr. Stanislav Pařez, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	3/1 per week
Completion:	credit, exam
Prerequisites:	KFY/E530 (An Introduction to Quantum Physics)
Course goal:	This lecture is closely continuous with Quantum mechanics II. Hydrogen atom. Spin. Pauli-equation. The approximate methods of the quantum mechanics (QM). The generalization of QM to many-particle systems. Identical particles and the principle of their indistinguishability. Bosons and fermions. The one-particle approximation. The Pauli exclusion principle. The basic idea of a relativistic quantum theory (Klein-Gordon and Dirac equation).

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Measurements and Processing of Experimental Data***
Course code:	KFY / EA51
ECTS:	5
Level of course:	master, bachelor
Teacher:	doc. RNDr. Jaroslav Pavlík, CSc.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	2/0 per week
Completion:	credit, exam
Course goal:	*1. Methods of signal measurements and data processing via single-purpose hardware devices and PC computers* Importance of analogue circuits in the frame of digital data processing, dynamic measurements (periodical signal and one-time process measurements, sampling frequency Nyquist frequency, frequency band of measurement signal – frequency filters, sampling below Nyquist frequency). Autonomous and distribute measuring systems, PC as measuring and control unit – plug-in measuring boards and PC mother board (structure and its possibility of application), galvanic separation of measuring signals (isolating amplifier with transformer, capacity and opto-electronical bond, conversion DC signals via U/f and f/U convertors), methods of conversion linearity arranging, multiplex units (signal processing from more inputs), sample circuits (sample/hold unit), instrumentation amplifier with programmable amplification, D/A and A/D convertors (principles of convertors application, methods of AD conversion – convertors with double integration, convertor with progressive approximation, parallel convertor). Data loading in memory during measurement (data relocation on the base interruption system). *2. Operational amplifiers and its applications for analogue signal processing* Ideal operational amplifier (OA) properties, sources of disturbing signals at real OA (input voltage asymmetry, resting input current, input current asymmetry, conversion characteristic – dynamic of conversion), basic circuits with OA (invert amplifier, non-invert amplifier, voltage duplicate, differential – instrumental amplifier, derivation amplifier, integration amplifier, logarithmic amplifier), protection of OA against overload of OA input and output, voltage asymmetry and resting input current OA compensation, grounding and shading of OA, resistance to disturbance via capacitive and inductive band. *3. Control systems and regulators* Basic of regulation and control of technological and laboratory processes (block diagram of regulator – regulation circuit, discrete, continuous and hybrid regulation circuit – sample period during direct digital regulation, analogue regulator, distribute systems. Type of regulator - binary regulator, proportional (P), integral (I), derivation (D) and PID regulator, adaptive regulator, stability and response of regulator system, traffic delay. Control of technological processes (run – up and run – down of technological system, arrangement of emergency situation – Real Time System (Watch Dog). Hardware dependability of control system – resistance to disturbance, industrial computers (protection of control system against vibrations, cooling with air filtration, backup source). *4. Basic of fuzzy logic for control systems*

	Differences between binary and fuzzy logic, three level logic. Fuzzy set – definition, universum x degree of veracity, degree of affiliation. Basic operation with fuzzy sets (intersection, unification, complement).Application of fuzzy logic, fuzzy logic in control applications (procedure of system design – fuzzyfication, evaluation of principles and criterions, defuzzyfication (method of center of gravity)).

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Numerical Methods of Hydrodynamics***
Course code:	KFY / E753
ECTS:	5
Level of course:	master
Teacher:	Doc. RNDr. Michal Varady, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	credit, exam
Course goal:	An introductory course on numerical methods based on finite differences algorithms applicable to the solution of partial differential equations in hydrodynamics. The course is eligible to students of computer modelling.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Computer Modelling – Particle Modelling***
Course code:	KFY / E523
ECTS:	5
Level of course:	bachelor
Teacher:	Doc. RNDr. Marek Malý, Ph.D., prof. Ing. Martin Lísal, DSc.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	regular consultations
Completion:	credit, exam
Course goal:	Hardware and software fundamentals of computational physics. Main directions of classical computational physics. Mathematical and computer modelling. Molecular modelling: simulation domains, particle interactions, Monte Carlo methods, molecular dynamics, dissipative particle dynamics, practical examples. Fluid modelling and hybrid modelling.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Seminar of Computer Modelling I***
Course code:	KFY / E501
ECTS:	5
Level of course:	bachelor
Teacher:	Doc. Doc. RNDr. Marek Malý, Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	0/2 per week
Completion:	credit
Course goal:	The purpose of this course is to practice the algorithms used in computer physics such as Molecular Dynamics, Monte Carlo, Simulated Annealing etc. Illustrative problems: Travelling Salesman Problem, Simulation and analysis of the hard spheres system, 1D hybrid modelling of plasma-probe interaction etc.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Programming C/C++***
Course code:	KFY / E235
ECTS:	5
Level of course:	bachelor
Teacher:	Doc. Doc. RNDr. Marek Malý, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	0/3 per week
Completion:	credit
Course goal:	In the course basics of programming in C/C++ language are presented and practised on PC lab. Students learn to think algorithmically and write console and simple GUI applications.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Physical Problems and Their Solutions - for secondary school teachers***
Course code:	KFY / E736
ECTS:	5
Level of course:	master
Teacher:	RNDr. Eva Hejnová, Ph.D., RNDr. Jiří Králík, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	0/2 per week
Completion:	credit
Prerequisites:	Basic Physics Courses
Course goal:	Seminar is aimed at the solving of physical problems from educational physics. The emphasis is given to solving questions concerning misconceptual ideas and some more difficult school problems.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Physics of Cosmic Plasma and magnetohydrodynamics***
Course code:	KFY / E865
ECTS:	5
Level of course:	master
Teacher:	Doc. RNDr. Michal Varady, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	2/1 per week
Completion:	credit, exam
Course goal:	The course presents an introduction to plasma physics with a stress to applications in the space physics and astrophysics. The first part of the course is devoted to the standard plasma theory (plasma properties, motion of individual charged particles in electromagnetic fields, magnetic mirroring, waves in plasma, transport theory, instabilities, fundamentals of kinetic theory) the second part of the course is devoted to the magnetohydrodynamic description of large scale plasma phenomena.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Modelling of Processes in Technology I***
Course code:	KFY / E864
ECTS:	5
Level of course:	bachelor, master
Teacher:	Doc. RNDr. Marek Malý, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	2/1 per week
Completion:	credit, exam
Course goal:	The goal of this course is to give an introduction to the software package Simulink for modelling and analysing dynamic systems. Students are acquainted with the basic tools needed to use the Simulink package. Besides of usage of predefined built-in functional blocks also creation of own functional blocks is demonstrated on examples. The possibility to combine Matlab and Simulink for problem solving is demonstrated as well.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Modelling of Processes in Technology II***
Course code:	KFY / E963
ECTS:	5
Level of course:	master
Teacher:	Doc. RNDr. Marek Malý, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	2/2 per week
Completion:	credit, exam
Course goal:	Introduction to artificial neural networks, genetic algorithms and some other heuristic optimisation algorithms.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Programming – Matlab***
Course code:	KFY / E130
ECTS:	5
Level of course:	bachelor
Teacher:	RNDr. Martin Švec, Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	0/3 per week
Completion:	credit
Course goal:	In the course basics of programming in Matlab language are presented and practised. Students learn to think algorithmically and write simple applications.

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Ion Analytic Methods***
Course code:	KFY / E293
ECTS:	5
Level of course:	master
Teacher:	doc. RNDr. Anna Macková, Ph.D.
Term:	winter/summer semester
Language of instruction:	english
Lectures/exercises:	18 hours in 3x 6 hour block including practice in laboratory
Completion:	credit
Prerequisites:	
Course goal:	The lecture is focused on the physical description of the main processes taking place in the interaction of charged and neutral particles with the solid, where there are a series of elastic and inelastic processes involving the incident particles and the atoms of the target material.
Abstract:	In addition, a neutron nuclear analytical method for elemental analysis, it means neutron activation analysis (NAA) and neutron depth profiling (NDP), will be part of lectures based on nuclear reactions with light nuclei of the studied material. Part of the lecture is a basic description of these phenomena, their physical principles and the use of these processes for qualitative and quantitative elemental analysis of materials. In the frame of the lecture main physical principles and applications of ion analytical methods will be described, which are used for the study of surface properties and solids interface. Ion beam analytical techniques and neutron beam techniques will be directly discussed in connection to significant applications in material science and technology. Ion elastic processes with target nuclei (RBS - Rutherford back scattering, ERDA - RBS-channeling) will be presented as well as inelastic processes with electrons of target atoms or nuclear reactions (PIXE - proton-induced retgenic fluorescence, NRA - analysis by nuclear reactions). At the end of the lecture is presented an overview of methods, their use and comparison of analytical possibilities they provide (sensitivity, depth and area resolution, lowest detectable concentration etc.) 1. Elastic and inelastic processes occurring after impact of charged particles on solids 2. Sources of charged particles for nuclear analysis 3. Basic principles of ion spectroscopy, X-ray. and gamma spectroscopy 4. Fundamentals of ion beam analytical methods - RBS, ERDA, quantitative and qualitative analysis 5. Fundamentals of Nuclear Analytical Ion Methods - PIXE PIGE, NRA, Quantitative and Qualitative Analysis 6. Method of ion channeling in crystalline materials 7. Ion microprobe and elemental lateral mapping 8. Application of ion beam analytical methods on different types of materials - sensitivity, element profiling, detection limits 9. Elastic and inelastic processes occurring after the neutrons impact on the solid 10. Neutron sources - nuclear reactors and instrumentation of neutron diffraction and NAA 11. Basic principles of neutron spectroscopy 12. NDP, NAA - nuclear methods and their qualitative and quantitative possibilities 13. Practical exercises at the Tandetron Laboratory, ÚJF AV ČR, v. I.

	Practical demonstration of knowledge by performing measurements and elaboration of a protocol / presentation on selected topics from the lecture circle.
Literature:	1. Tirira J., Serruys Y., Trocellier P.: Forward recoil spectrometry, Plenum Press, New York 1996. Feldman L.C., Mayer J.W.: Fundamentals of surface and thin film analysis, North-Holland, New York 1986. 2. Tesmer J. R., Nastasi M.: Handbook of modern ion beam materials analysis, Materials research society, Pittsburgh 1995. 3. Frank L., Král J.: Metody analýzy povrchů; iontové, sondové a speciální metody, Academia, Praha 2002. 4. A. Mackova, A. Pratt, Handbook of Spectroscopy: Second, Enlarged Edition,2-4 (2014)741-778, Ion/Neutral Probe Techniques (Book Chapter). 5. C. Jeynes, M.J. Bailey, N.J. Bright, M.E. Christopher, G.W. Grime, B.N. Jones, V.V. Palitsin, R.P. Webb, ‘‘Total IBA’’ – Where are we?, Nuclear Instruments and Methods in Physics Research B 271 (2012) 107–118. 6. A. Zucchiatti, A. Redondo-Cubero, Ion beam analysis: New trends and challenges, Nuclear Instruments and Methods in Physics Research B 331 (2014) 48–54. 7. C. Jeynes, N. P. Barradas, and E. Szilágyi, Accurate Determination of Quantity of Material in Thin Films by Rutherford Backscattering Spectrometry, Anal. Chem., 2012, 84 (14), pp 6061–6069. 8. Kim Man Yu, Ion Beam Analysis in Materials Science, Lawrence Berkeley National Laboratory. 9. https://drive.google.com/file/d/0B2JUoXR-XKz6OWNhZWRjNGYtNTFmNC00YzFiLTkzYjItNjMzOGI2MTlhNmVk/view

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Physical methods of thin film deposition***
Course code:	KFY / E223
ECTS:	5
Level of course:	master
Teacher:	Mgr. Jindřich Matoušek, Ph.D.
Term:	summer semester
Language of instruction:	english
Lectures/exercises:	2/0 per week
Completion:	credit, exam
Prerequisites:	
Course goal:	The aim of this course is to achieve elementary orientation in the field of thin film deposition technology. The students should understand the relation between the composition and properties of the thin films as well as the influence of the deposition parameters. The blocks covered by this subject are: Plasma discharges (glow discharge and arc) – basic propereties, interactions of plasma discharge with electrodes and surfaces. Vacuum evaporation – principle, homogeneity of deposition. Sputtering – principle, DC, pulsed DC and RF sputtering, magnetrons, reactive sputtering. Other methods of thin film deposition – laser ablation, IBAD, Langmuir-Blodgett films, anodic oxidation. Chemical and physicochemical deposition methods – CVD, PE CVD Characterization of the deposition processes – deposition rate measurement, OES, QMS Substrate cleaning and preparation – chemical treatment, annealing, ion etching
Abstract:	
Literature:	

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Introduction to Supramolecular chemistry***
Course code:	KFY / E701
ECTS:	5
Level of course:	
Teacher:	Prof. RNDr. Pavla Čapková, DrSc
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	3/2 per week
Completion:	credit, exam
Prerequisites:	Basic knowledge of organic and inorganic chemistry
Course goal:	Explanation of basic principles of supramolecular chemistry and its use in nanotechnologies
Abstract:	Principles of supramolecular chemistry; Weak intermolecular interactions and H-bond; Host-guest supramolecular structures; Examples of supramolecular complexes and functional nanostructures; Intercalation chemistry; Self-organized structures; Computer design of supramolecular structures;
Literature:	Supramolecular Chemistry – Fundamentals and Applications; Advanced Textbook; Katsuhiko Ariga and Toyoki Kunitake

Faculty/Institute:	**Faculty of Science / Department of Physics**
Course title:	***Programming - Fortran***
Course code:	KFY / EFORT
ECTS:	5
Level of course:	bachelor
Teacher:	Mgr. Martin Svoboda Ph.D.
Term:	winter semester
Language of instruction:	english
Lectures/exercises:	1/3 per week
Completion:	credit, exam
Course goal:	Students will learn the basics of programming and the application of getting knowledge in the Fortran programming language. The main emphasis is on the adoption of algorithmic thinking.

DEPARTMENT OF GEOGRAPHY

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***English for Science***
Course code:	KGEO / E403
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Jan Píša, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The course is intended to improve the specialized geographical word power and communication skills of students as well as to show the possibilities of finding and interpreting different geographical information, and finally to show how to present the results of own research or another work.
Abstract:	1. Introductory lesson; 2. Scientific journals and other sources; 3. Writing an abstract I; 4. Writing an abstract II - practical skills; 5. Designing a research topic; 6. Reading scientific papers I - analyzing the structure; 7. Reading scientific papers II - heart of the matter; 8. Discussing the geographical problem I - environmental issues; 9. Discussing the geographical problem II - social issues; 10. Discussing the geographical problem III - regional issues; 11.-13. Presentation of geographical issue; 14. Closing lesson

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Regional geography of Northwestern Bohemia***
Course code:	KGEO / E100
ECTS:	10
Level of course:	Bachelor, Master
Teacher:	Assoc. Prof. Mgr. Pavel Raška, Ph.D. et al.
Term:	Summer + Winter
Language of instruction:	English
Lectures/exercises:	5 day per semester
Completion:	exam
Course goal:	The course focuses on selected geographical aspects of NW Bohemia, mainly as follows: (a) location and geodiversity – evolution of natural environment, landscape types, (b) development of settlement, history and recent demographical trends, (c) economic significance of the region, (d) cross-border relations with Germany (Saxonia), (e) environmental problems and (f) regional development issues. Students are attending consultations, where they get tasks and discussion questions for the above mentioned issues, and concurrently they work on a project covering these issues.
Abstract:	1. Location and geodiversity 2. Development of settlement 3. History and recent demographical trends 4. Economic significance of the region 5. Cross-border relations with Germany (Saxony) 6. Environmental problems 7. Regional development issues **The course is completed with individual reports (5 pages) based on reading of assigned literature and field observations.*

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Regional geography of the Czech Republic***
Course code:	KGEO / E101
ECTS:	10
Level of course:	Bachelor, Master
Teacher:	Assoc. Prof. Mgr. Pavel Raška, Ph.D. et al.
Term:	Summer + Winter
Language of instruction:	English
Lectures/exercises:	5 day per semester
Completion:	exam
Course goal:	The course focuses on selected geographical aspects of the Czech Republic, mainly as follows: (a) position in Europe, (b) geodiversity – evolution of natural environment, landscape types, (c) development of settlement, history and recent demographical trends, (d) economic significance, (e) cross-border relations, (f) environmental problems and (g) regional development issues. Students are attending consultations, where they get tasks and discussion questions for the above mentioned issues, and concurrently they work on a project covering these issues.
Abstract:	1. Location and geodiversity 2. Development of settlement 3. History and recent demographical trends 4. Economic significance of the region 5. Cross-border relations with Germany (Saxony) 6. Environmental problems 7. Regional development issues **The course is completed with individual reports (5 pages) based on reading and comparison of selected issues (e.g. environmental and developmental perspectives) with country/region of origin of the foreign student.*

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***One-day Geographical Excursion A / Geographische Exkursion A***
Course code:	KGEO / E023
ECTS:	5
Level of course:	Bachelor, Master
Teacher:	RNDr. Ivan Farský, CSc., Mgr. Jiří Riezner, Ph.D.
Term:	Winter + Summer **excursions are scheduled each semester according to the number of students. In case of small numbers, the excursion may be cancelled.*
Language of instruction:	Deutsch
Lectures/exercises:	1 day per semester
Completion:	exam / Prüfung
Course goal:	Eins-, Zweitägige Exkursion und Feldpraxis dient zur praktischen Übung. Die Studenten einzelne Aufgaben zu bearbeiten haben (schriftlich oder praktisch). Die auch Terrainbeobachtungen machen. Die Anforderung: Ein Exkursionsplan an der Lehrstuhlseite zu beobachten (Semester Anfang), sich in STAG zu verschreiben. Bearbeiteten Itinerar spätestens 1 Monat nach der Exkursion zur Kontrolle geweben. Gehalt: die Funktionszonen festzustellen, die Naturelemente zu beobachten. Literatur: Regional Fachliteratur (Atlanten, Karten, Jahrbüchr usw.) **excursion is also available for English speaking students.*
Abstract:	- funktional Zonen - Natur und Umwelt - regional Geographie

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***One-day Geographical Excursion B / Geographische Exkursion B***
Course code:	KGEO / E024
ECTS:	5
Level of course:	Bachelor, Master
Teacher:	RNDr. Ivan Farský, CSc., Mgr. Jiří Riezner, Ph.D.
Term:	Winter + Summer **excursions are scheduled each semester according to the number of students. In case of small numbers, the excursion may be cancelled.*
Language of instruction:	Deutsch
Lectures/exercises:	1 day per semester
Completion:	exam / Prüfung
Course goal:	Eins-, Zweitägige Exkursion und Feldpraxis dient zur praktischen Übung. Die Studenten einzelne Aufgaben zu bearbeiten haben (schriftlich oder praktisch). Die auch Terrainbeobachtungen machen. Die Anforderung: Ein Exkursionsplan an der Lehrstuhlseite zu beobachten (Semester Anfang), sich in STAG zu verschreiben. Bearbeiteten Itinerar spätestens 1 Monat nach der Exkursion zur Kontrolle geweben. Gehalt: die Funktionszonen festzustellen, die Naturelemente zu beobachten. Literatur: Regional Fachliteratur (Atlanten, Karten, Jahrbüchr usw.) **excursion is also available for English speaking students.*
Abstract:	-funktional Zonen - Natur und Umwelt - regional Geographie

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***One-day Geographical Excursion C / Geographische Exkursion C***
Course code:	KGEO / E064
ECTS:	5
Level of course:	Bachelor, Master
Teacher:	RNDr. Ivan Farský, CSc., Mgr. Jiří Riezner, Ph.D.
Term:	Winter semester **excursions are scheduled each semester according to the number of students. In case of small numbers, the excursion may be cancelled.*
Language of instruction:	Deutsch
Lectures/exercises:	1 day per semester
Completion:	exam / Prüfung
Course goal:	Eins-, Zweitägige Exkursion und Feldpraxis dient zur praktischen Übung. Die Studenten einzelne Aufgaben zu bearbeiten haben (schriftlich oder praktisch). Die auch Terrainbeobachtungen machen. Die Anforderung: Ein Exkursionsplan an der Lehrstuhlseite zu beobachten (Semester Anfang), sich in STAG zu verschreiben. Bearbeiteten Itinerar spätestens 1 Monat nach der Exkursion zur Kontrolle gweben. Gehalt: die Funktionszonen festzustellen, die Naturelemente zu beobachten. Literatur: Regional Fachliteratur (Atlanten, Karten, Jahrbüchr usw.) **excursion is also available for English speaking students.*
Abstract:	- funktional Zonen - Natur und Umwelt - regional Geographie

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***One-day Geographical Excursion D / Geographische Exkursion D***
Course code:	KGEO / E065
ECTS:	5
Level of course:	Bachelor, Master
Teacher:	RNDr. Ivan Farský, CSc., Mgr. Jiří Riezner, Ph.D.
Term:	Winter + Summer **excursions are scheduled each semester according to the number of students. In case of small numbers, the excursion may be cancelled.*
Language of instruction:	Deutsch
Lectures/exercises:	1 day per semester
Completion:	exam / Prüfung
Course goal:	Eins-, Zweitägige Exkursion und Feldpraxis dient zur praktischen Übung. Die Studenten einzelne Aufgaben zu bearbeiten haben (schriftlich oder praktisch). Die auch Terrainbeobachtungen machen. Die Anforderung: Ein Exkursionsplan an der Lehrstuhlseite zu beobachten (Semester Anfang), sich in STAG zu verschreiben. Bearbeiteten Itinerar spätestens 1 Monat nach der Exkursion zur Kontrolle geweben. Gehalt: die Funktionszonen festzustellen, die Naturelemente zu beobachten. Literatur: Regional Fachliteratur (Atlanten, Karten, Jahrbüchr usw.) **exkursion is also available for English speaking students.*
Abstract:	1. das Marketing Struktur - der Reiseverkehr 2. Besuch der Messe

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Development Problems of Czech Regions***
Course code:	KGEO / E304
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Silvie R. Kučerová, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/1 per week
Completion:	exam
Course goal:	Regional development issues The aim of the course is to present and discuss selected issues of regional and local development, regional policy and territorial management. The themes are presented on the example of Czechia and European countries. The emphasis will be put on the comparison with the situation in students´ homeland.
Abstract:	1. Introduction 2. Regional disparities in the Czech Republic 3. Public administration 4. Heritage, values conservation 5. Regional policy 6. EU funds 7. Tools of regional policy 8. Regional development in borderland 9. Strategy of local and regional development 10. Selected problems of RD in Usti nad Labem region I-IV

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Field Practice in Human Geography***
Course code:	KGEO / E312
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Zdeňka Smutná
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	0/2
Completion:	exam
Course goal:	The main aim of this course is to examine theoretical and practical knowledge of general and regional social geography by resolution of specific research tasks in the model locations. In this course students will acquire and practice geographic research methods.
Abstract:	Introduction the methods of human geographic research Practical application of research methods: - in the geography of population and settlements - in the geography of agriculture - in the geography of industry - in the geography of trade and services - in the geography of tourism

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Physische Geographie von Tschechien (Selected Chapters from Physical Geography of Czechia)***
Course code:	KGEO / E218
ECTS:	5
Level of course:	Master
Teacher:	Mgr. Jiří Riezner, Ph.D.
Term:	Sommersemester
Language of instruction:	Deutsch
Lectures/exercises:	2/0 für die Woche
Completion:	exam / Prüfung
Course goal:	Physische Geographie von Tschechien - Im Rahmen der Veranstaltung wird ein Überblick über: die physisch-geographischen Rahmenbedingungen Tschechiens und ausgewählten Natur- und Kulturlandschaften besonderer Bedeutung gegeben.
Abstract:	1. Geologische Entwicklung und Verhältnisse; 2. Geomorphologische; Entwicklung und Gliederung; 3. Klima; 4. Gewässer; 5. Böden; 6. Vegetation und Tierwelt; 7. Böhmische Mittelgebirge, Erzgebirge; 8. Riesengebirge, Böhmische Schweiz; 9. Böhmisches Paradies, Křivoklátsko; 10. Třeboňsko, Böhmerwald; 11. Böhmischer Karst, Broumovsko; 12. Thayathal, Pálava, Mährischer Karst; 13. die Mährisch-Schlesische Beskyden, die Weißen Karpaten; 14. Altvatergebirge, Litovelské Pomoraví)

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Geographical Information Systems I***
Course code:	KGEO / E202
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Martin Dolejš
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The introductory course of Geographical Information Systems aims at explaining basic terminology, introducing software tools and detailed description of the ESRI products and their functions.
Abstract:	1. Software tools for GIS. 2. Basic philosophy of ArcGIS. 3. Working environment in ArcGIS 10.x. 4. Map field. 5. Geodatabase, attributes, data selection. 6. Metadata, ArcCatalogue. 7. Geospatial analysis. 8. Map construction. 9. Working environment in ArcMap. 10.–12. Individual work. 13. Presentation of semestral projects.

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Geographical Information Systems II***
Course code:	KGEO / E300
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Martin Dolejš
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The course aims at advanced methods of data processing in GIS, mainly on the applications of 3d Analyst, Spatial Analyst, Network Analyst and other modules.
Abstract:	1. Using GIS in geographical projects, specific tools of GIS. 2. Principles of extensions in ArcGIS. 3. Map Algebra. 4. Spatial Analysis. 5. Creating a analysing DEM. 6. Optimal route, corridor, viewshed. 7. Hydrological analysis. 8. Geostatistics I. 9. Geostatistics II. 10. Maplex. 11. Mapbook/Publisher. 12. Model Builder.

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Urban Environmentalistics***
Course code:	KGEO / E030
ECTS:	5
Level of course:	Master
Teacher:	Assoc. Prof. Mgr. Pavel Raška, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/1 per week
Completion:	exam
Course goal:	The course introduces students to fundamental problems of urban environment contextualized in the development of cities through the history. The first part is devoted to conceptualization of the “urban” and rationalization of the study of urban environment to address global challenges. The second part gives an overview of specificities of urban environment (soils, climate, hydrologic cycle etc.) in contrast to (semi-)natural areas. Final part provides an introduction to planning theories and paradigms of the 20th century, with emphasis goven to environmental issues.
Abstract:	1. Defining urban, rural and rurban 2. Urban environment and global challenges I 3. Urban environment and global challenges II 4. Origin and development of cities 5. Historical and “new” cities 6. Urban geology and soils 7. Urban climate 8. Urban hydrological cycle 9. Urban greenery and parks 10. Natural hazards and risks 11. Urbanism and architecture in the 20th Century

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Methods and Application of Historical Geography***
Course code:	KGEO / E310
ECTS:	5
Level of course:	Master
Teacher:	Assoc. Prof. Mgr. Pavel Raška, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The course is designed as a cycle of discussion of scholarly papers devoted to data, methods and themes in historical geography/environment history. Students are expected carry an individual minor research based on primary data.
Abstract:	1. Historical geography and environmental history 2. The history and the future in landscape science 3. Documentary proxies in historical geography 4. Historical event inventories and time series 5. Old maps 6. Narrative sources and narrative analyses 7. Visual sociology 8. Complexities in land use change studies 9. Presentation of students´ projects I 10. Presentation of students´ projects II 11. Presentation of students´ projects III

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***GIS Project***
Course code:	KGEO / E211
ECTS:	5
Level of course:	Master
Teacher:	Mgr. Martin Dolejš
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The course aims to develop students' skills through team GIS project, including research design and hypothesis, data collection, design of the suitable methodological approach, data processing and presentation (visualisation).
Abstract:	Theory: Introduction, problems of large GIS projects in practice, concepts, redaction and work in teams. Practice: Processing of the assigned part of the team GIS project and research report summary and presentation.

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Economic geography I***
Course code:	KGEO / E306
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Vladan Hruška, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	Basic economic terms and concepts will be discussed within this course. The role of the state in the economy and other topics such as growth-development or environment – economy relation, geography of labour market, geography of finance will be discussed.
Abstract:	1. Economy – basic terms 2. Introduction to economic geography 3. Development and economic growth 4. Capitalist economies and political economy 5. Uneven development 6. State and economy 7. Socialist state and development 8. Geography of finance 9. Economy and environment 10. Geography of labour market 11. Excursion in a local enterprise 12. Excursion in an old industrial area of Ústí nad Labem 13. Course revision

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Economic geography II***
Course code:	KGEO / E405
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Vladan Hruška, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	Course focuses on the topic of globalisation and its impact on spatial distribution of economic activities. Special attention is devoted to the concept of global commodity chains, transnational corporations and geography of services.
Abstract:	1. Places of production and deindustrialisation 2. Commodity chains 1 3. Commodity chains 2 4. Technological changes 5. Transnational corporations 1 6. Transnational corporations 2 7. Geography of consumption 8. Geography of services 9. Geography of retail 10. Distance and economic geography 11. Excursion in a local enterprise 12. Excursion in an old industrial area of Ústí nad Labem 13. Course revision

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Theories and concepts of rural geography***
Course code:	KGEO / E512
ECTS:	5
Level of course:	Master
Teacher:	Mgr. Vladan Hruška, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	exam
Course goal:	Course aims to inform students about basic concepts and theories of rural geography. Development of rural studies will be discussed and different approaches to the definition of rural will be introduced. Transformation of agriculture and rural space of developed world will be analysed.
Abstract:	1. Development of rural studies in the UK and Czechia 2. Definitions of rural 1 3. Definitions of rural 2 4. Transformation of agriculture – productivist agriculture 5. Transformation of agriculture – multifunctional agriculture 6. Alternative food networks 7. Rural restructuring 8. Transformation of post-socialist rural economies 9. Amenity migration 10. Rural development approaches 11. Rural idyll 12. Excursion in Ústí nad Labem surrounding 13. Course revision

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Cultural Geography***
Course code:	KGEO / E301
ECTS:	5
Level of course:	Master
Teacher:	Assoc. Prof. Jan Daniel Bláha, Ph.D.
Term:	Winter/Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	exam
Course goal:	The course focuses on following basic features of cultural geography: nations, languages, religions, cultural heritage, customs and traditions. Another important aspect of the course is the concept of culture and its anthropological definition, as well as basic terms and constructs such as "cultural diffusion" and "cultural region". The specifics of formation of nations and religions, their development, geographical distribution, causes of ethnic and religious conflicts in the world are studied. Attention is also paid to the macro-regional differentiation of the world and the formation of civilizations by different authors. Students elaborate and present their own projects focused on selected ethnic/sub-cultural group or topics of cultural geography.
Abstract:	1. The term "culture". 2. Basic principles of culture. 3. Dynamics and development of culture (cultural change). 4. Groups in contact (acculturation and cultural diffusion) and categorization of culture. 5. Cultural geography and geography of culture (discipline overview and methodology). 6. Anthropogenesis; origin and development of civilization. 7. Language and Religion. 8. Typology of nations and ethnicity. 9. Local and regional culture (concept of cultural region). 10. Cultural heritage. 11. World cultural macro-regions and their specifics (global view of culture).

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***EU and Central Europe***
Course code:	KGEO / E516
ECTS:	4
Level of course:	Bachelor
Teacher:	Mgr. Jan Píša, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	exam
Course goal:	The course is focused on understanding the structure of the basic components and features of the natural sphere of Central Europe in the context of the EU, on evaluating their interaction and influence on the development of society. Another part is devoted to the specification of physical-geographical regions, formed on the basis of their internal homogeneity.
Abstract:	1. Literature, sources and methods of physical-geographical research in the European area. 2. Definition of Central Europe. Physical-geographic division of Europe, delimitation of territory. Geological structure and geomorphological conditions. 3. Climate. 4. Leadership. 5. Soils. 6. Fauna and flora. 8. Nature protection. 9. The most important physical-geographical goals of tourism. 10. Physical-geographical regionalization. 11. Hercynian Central Europe. 12. Alpine-Carpathian system. 13. Natural potential and risks.

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Global problems***
Course code:	KGEO/E517
ECTS:	4
Level of course:	Bachelor
Teacher:	Mgr. Zdeňka Smutná; Mgr. Tomáš Matějček, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/0
Completion:	exam
Course goal:	The aim of the course is (1) to introduce a system of knowledge about the global problems of our time and to contribute to a coherent, correct understanding of the planetary community of people and the unity of nature and society, (2) to contribute to the formation of "global thinking" as a counterbalance to narrowly understood group interests, (3) developing an interest in human issues of a general social nature, (4) enriching students with special and general habits and skills enabling them to independently acquire and evaluate information of a globalist (geo-globalist) nature, (5) contributing to an understanding of the specific manifestations of global problems in the major regions and countries of the contemporary world.
Abstract:	Focus of lectures: 1. Global issues, globalist, geopolitics. 2. Atmospheric pollution. Global climate change. 3. Threats to the land. Threats to biodiversity. 4. Deforestation. Biological invasions. 5. Waste production. 6. Water problem. 7. The problem of war. International organized crime. International terrorism. 8. The demographic problem. Ethnic and confessional problems. 9. Drug trafficking. HIV/AIDS. 10. Nutrition problem - famines and food waste. 11. The energy and resource problem. 12. Uneven development - contrasts in the contemporary world. 13. 'Anti-globalism', de-growth and other alternative movements.

Faculty/Institute:	**Faculty of Science / Department of Geography**
Course title:	***Food geography***
Course code:	KGEO/E518
ECTS:	4
Level of course:	Bachelor/Master
Teacher:	Mgr. Zdeňka Smutná
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/1
Completion:	exam
Course goal:	The aim of the course is to familiarize students with the geography of agriculture and the geography of food. In the first part, the key theories and concepts of these geographical subdisciplines will be presented, followed by the issue of conventional agri-food systems in the context of globalization, while partial problems associated with the production and consumption of food with regard to sustainability will be presented. In the form of excursions, examples of good practice in terms of bringing food producers closer to consumers, which contribute to strengthening sustainability, will be presented.
Abstract:	1. Introduction to the geography of agriculture and the geography of food 2. Agri-food systems and globalization 3. Food production and climate change 4. Global and regional value chains in the agri-food system 5. Multinational corporations in third world countries 6. Consumerism 7. Food insecurity and justice 8. Alternative approaches in agro-food systems 9. Agricultural policy 10. Localization, sustainability and challenges 11. Innovation for sustainability 12. Excursion 13. Excursion

DEPARTMENT OF CHEMISTRY

Faculty/Institute:	**Faculty of Science / Department of Chemistry**
Course title:	***General Chemistry***
Course code:	KCH / E100
ECTS:	5
Level of course:	Bachelor
Teacher:	Ing. Magda Škvorová, Ph.D.
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	3/4 per week
Completion:	Exam
Course goal:	The aim of the course is to present modern chemistry and its historical context. Students will be acquainted with terms common to all branches of chemistry. Key topics of the course are: (i) chemical structure of matter, (ii) states, classification and properties of substances, (iii) fundamentals of thermodynamics and its application in chemistry, and (iv) reaction kinetics.
Abstract:	1. History of chemistry. Basic chemical laws and quantities. 2. Modern chemistry among other natural sciences and its division. 3. Structure of matter. Elementary particles and field. Atomic nucleus. Historical models of atom. 4. Quantum-mechanical model of atom. 5. Chemical bond. Structure and reactivity of molecules. 6. Intermolecular forces. 7. States of matter. Mixtures, solutions and colloids. 8. PVT behaviour of fluids. 9. Basics of thermodynamics. 10. Thermochemistry. 11. Phase equilibria. 12. Chemical equilibria. 13. Chemical kinetics. 14. Theoretical principles of modern analytical methods.

Faculty/Institute:	**Faculty of Science / Department of Chemistry**
Course title:	***Introduction to Inorganic and Organic Chemistry***
Course code:	KCH / E101
ECTS:	10
Level of course:	Bachelor
Teacher:	doc. Ing. Jan Čermák, CSc., RNDr. Václav Šícha, Ph.D., Mgr. Thu Huong Nguyen Thi, Ph.D.
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	3/1 per week
Completion:	Exam
Course goal:	The aim of the inorganic part is to acquaint students with topics related to the periodic table of elements. In this course we will discuss individual chemical elements, their occurrence in nature, chemical and physical properties, laboratory preparation, industrial production, important compounds and application. In the organic part students will learn fundamentals of nomenclature and stereochemistry and acquaint themselves with chemistry of selected classes of organic compounds.
Abstract:	1. Periodic table of the elements 2. Basic elements and their chemical compounds (hydrogen and oxygen) 3. Noble gases, halogens, chalcogens 4. Boron group, carbon group, nitrogen group 5. Alkali metals, alkaline earth metals 6. Basic characteristic of metals, production of metals 7. Transition elements 8. Systematic IUPAC nomenclature. Alkanes and cycloalkanes 9. Stereochemistry 10. Haloalkanes. Nucleophilic substitution and elimination reactions 11. Oxidation-reduction in organic chemistry. Alcohols, ethers, and thiols, sulfides 12. Alkenes and alkynes. Addition reaction 13. Arenes. Electrophilic aromatic substitution 14. Aldehydes and ketones. Nucleophilic addition to the carbonyl group

Faculty/Institute:	**Faculty of Science / Department of Chemistry**
Course title:	***Applied Thermodynamics: Phase behaviour***
Course code:	KCH / E103
ECTS:	5
Level of course:	bachelor
Teacher:	Ing. Magda Škvorová, Ph.D.
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	2/1 per week
Completion:	exam
Course goal:	The aim of this course is to apply the theoretical knowledge of physical chemistry to solve various chemical-engineering problems. Modern PC software (EXCEL and MAPLE) and laboratory equipment are used to complete the courses.
Abstract:	1. Critical point, critical quantities and their estimation. 2. State behaviour: Introduction 3. Virial equation of state 4. Equation of state; Principle of corresponding states 5. State behaviour (SB) of fluids and empirical laws for SB estimation of mixtures 6. Thermodynamics: Introduction 7. Thermodynamics of the ideal gas; standard states 8. Thermodynamics of real gas: excess quantities 9. Heat and work determination 10. Partial molar quantities 12. Phase equilibrium: Introduction 13. Vapour-liquid equilibrium 14. Liquid-liquid and liquid-solid equilibrium; solubility of gases.
Requirements on student/Prerequisites	Physical chemistry (bachelor degree)

Faculty/Institute:	**Faculty of Science / Department of Chemistry**
Course title:	***Experimental Methods: Laboratory Tutorials***
Course code:	KCH / E105
ECTS:	5
Level of course:	bachelor
Teacher:	Ing. Magda Škvorová, Ph.D.
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	0/3 per week
Completion:	exam
Course goal:	The aim of this course is laboratory experiments for determination of physico-chemical properties of pure substances or mixtures in liquid and solid states. Students will realize several laboratory experiments.
Abstract:	Overview of proposed experimental works (student should finish 5 of them depending on actual possibilities of individual experimental instruments) 1. Calorimetric study of enthalpy of solution, reaction and neutralization 2. Determination of dissociation constants of weak acids by several methods 3. Refractometery of pure compounds 4. Determination of density, viscosity and fluidity of pure liquids by several methods 5. Determination of density, excess molar volumes and refractive index of binary systems in temperature dependence 6. Distillation curve of binary alcohol mixture
Requirements on student/Prerequisites	Physical chemistry (bachelor degree)

Faculty/Institute:	**Faculty of Science / Department of Chemistry**
Course title:	***Introduction to programming with MATLAB***
Course code:	KCH / E108
ECTS:	5
Level of course:	bachelor
Teacher:	doc. Ing. Jaromír Havlica, Ph.D.
Term:	Winter + Summer
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	exam
Course goal:	This course teaches computer programming in MATLAB. It is suitable for students with little or no previous programming experience. MATLAB combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly. The course includes basic use, graphical representations, and programming in MATLAB software.
Abstract:	Introduction to Matlab Basic Mathematics Operations on matrix M files Data files and Data types File Input/Output Graphics 2D plots 3D plots Matlab programming Programmer's Toolbox Loops and conditional statements Functions Numerical methods and simulations

DEPARTMENT OF INFORMATICS

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Algorithms and Programming I***
Course code:	KI/EAPR1
ECTS:	7
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Ing. Mgr. Pavel Beránek, RNDr. Jiří Škvára, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The introductory course of algorithms and programming (first part) is focused on the basic principles of procedural and object-oriented paradigm including representation of basic collections (strings, lists, dictionaries) and the elementary algorithms above them. The course is intended for beginners (no prior knowledge of programming is required). Lectures and exercises will be in Python programming language.
Abstract:	1. Basic terminology and principles of object-oriented programming, objects (values) of main classes (numbers, logical values) and their methods 2. Variables, standard input and output, program branching (if-then construction) 3. User functions (input parameters, return values, scope of variables), tuples 4. Strings and their methods, indexing, modifiable referenced values (reference semantics) 5. Loops (while and for), premature termination of loops 6. Lists (interfaces), asymptotic (time) complexity 7. Important algorithms over lists (duplication, filtering, reduction) 8. Dictionaries (interfaces, use cases: representation of associative fields, sparse fields and caches) 9. Hash tables (internal implementation, hash functions) 10. File input and output (text files) 11. File input and output (binary files), byte arrays 12. Exceptions and basic exception handling, context manager (with) and resource management 13. Summary
Requirements on student/Prerequisites	Exam: seminar work or successful completion of a written test Prerequisites: none, elementary programming experience is an advantage

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Algorithms and Programming II***
Course code:	KI/EAPR2
ECTS:	7
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Ing. Mgr. Pavel Beránek, RNDr. Jiří Škvára, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The second part of the introductory course of algorithmization and programming, which is focused on the implementation of own abstract data structures (e.g. connection lists, trees, queues and stacks) and operations on them by mean of OOP classes. Students will also get to know the basic means of object polymorphism (interface and inheritance) with emphasis on the representation of iterators. Lectures and exercises will be in Python programming language.
Abstract:	1. Implementation of classes (data fields, methods, constructors) 2. Abstract data types (ADT), implementation of sequential data structures (queue, stack, sorted list) 3. Implementation of algorithms over sequential collections - search algorithms 4. - 5. Implementation algorithms over sequential collections - sorting algorithms 6. Linked structures and their object implementation (linked lists, trees, etc.) 7. - 8. Implementation of algorithms over linked structures 9. Assignment of seminar work, discussion and implementation proposal 10. Interfaces (protocols or abstract base classes in Python parlance), iterators and their implementations, interfaces of basic collections 11. Complete implementation of own collection 12. Inheritance (advantages and disadvantages) 13. Practical use of inheritance
Requirements on student/Prerequisites	Exam: preparation and oral defense of a seminar work Prerequisites: basics of procedural programming (loops, procedures), basics of object-oriented programming (class, methods), interface of containers (list, dictionary) and file streams (preferably in Python)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Data Mining Techniques Based on R Software***
Course code:	KI/EDMR
ECTS:	7
Level of course:	Bachelor
Teacher:	prof. Sergii Babichev, DSc.
Term:	Summer semester, Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	This e-learning course is focused to students who are planning to work as IT specialists in the fields related to analytics, data mining solutions, marketing etc., who want to learn about both the practical application and implementation of data mining methods based on one of the modern programming languages R. The aim of the course is to acquire knowledge and practical experience in the field of information processing, including the acquisition of useful skills. Software R offers a large number of methods for implementing of the functional programming paradigm during the corresponding project creation and implementation. For these reasons, the proposed course is actual and interesting for students who are focused to development and practical implementations of IT technologies based on R language. The course is available on moodle webpage by link: https://kacer.ujep.cz/course/view.php?id=65 . Access for guests: data_mining_R
Abstract:	1) Data visualization techniques in R 2) Basic concepts of regression analysis 3) Basic of data exploration in R 4) Techniques of data managing and transforming 5) Basics of data clustering. Clustering quality criteria 6) K-means, C-means and Hierarchical Clustering Algorithms in R 7) Density-Based DBSCAN and OPTICS Clustering Algorithms in R 8) Data Classification: Basic Concepts and Application with R 9) Basics of Fuzzy Logic. Steps of Fuzzy Inference Process Implementation 10) Practical Implementation of Fuzzy Inference Techniques Based on R Software Tools 11) Basics Concepts of Time Series Processing. Techniques of Time Series Analysis and Processing Based on R Software Tools 12) Applying Data Mining Techniques for Data Processing Based on R Software Tools
Requirements on student/Prerequisites	Prerequisites: Basics of programming in R

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Internet of Things with Raspberry Pi and Arduino***
Course code:	KI/EIOT
ECTS:	7
Level of course:	Bachelor
Teacher:	prof. Sergii Babichev, DSc.
Term:	Summer semester, Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course "Internet of Things with Raspberry Pi and Arduino" provides a comprehensive overview of integrating modern technologies and internet connectivity with practical applications. This course is aimed at students and enthusiasts who want to learn how to use Raspberry Pi and Arduino to create innovative IoT (Internet of Things) projects. The course combines theoretical studies with practical laboratory exercises, allowing participants to gain solid foundations and practical experience necessary for successful work in the field of IoT. It is ideal for those interested in technology and wanting to expand their skills in modern digital systems and smart devices.
Abstract:	1. Introduction to Internet of Things and Cisco Packet Tracer: An overview of IoT concepts and an introduction to the Cisco Packet Tracer tool for network simulations. 2-3. Sensors and Actuators; Basics of Arduino and Raspberry Pi: Exploring the fundamental components of IoT systems, including sensors and actuators, and learning the basics of using Arduino and Raspberry Pi platforms. 4. Experimenting with LED and LCD using Arduino and Raspberry Pi: Practical exercises focused on controlling LED and LCD displays with Arduino and Raspberry Pi. 5-6. Interfacing Sensors and Actuators with Raspberry Pi using I2C Mode: Hands-on experience with interfacing various components like Relay, DC motors, DHT-sensor, ultrasonic sensor, etc., with Raspberry Pi using I2C communication. 7. Python GUI with Tkinter, Raspberry Pi, and Arduino: Developing graphical user interfaces using Python's Tkinter library, integrated with Raspberry Pi and Arduino for controlling and monitoring IoT devices. 8. Data Acquisition with Python and Tkinter: Learning about data acquisition techniques using Python and Tkinter for effective data handling in IoT applications. 9-10. Connection to the Cloud; Smart IoT Systems: Understanding cloud connectivity for IoT systems and developing smart IoT solutions that leverage cloud platforms. 11. Blynk Application with Raspberry Pi: Utilizing the Blynk platform to create IoT applications with Raspberry Pi. 12-13. Development of Various IoT Projects using Raspberry Pi and Arduino: Advanced module focusing on the creation of diverse IoT projects, integrating the knowledge and skills acquired in the previous modules.
Requirements on student/Prerequisites	Prerequisites: Basics of programming in Python, C++

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Machine Learning Based on Python and R***
Course code:	KI/EMLPR
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	prof. Sergii Babichev, DSc.
Term:	Summer semester, Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course is designed to provide comprehensive training in machine learning (ML) techniques using two of the most popular programming languages in data science: Python and R. This course is suitable for students, data scientists, software engineers, and analysts who wish to deepen their understanding of machine learning and its applications. This course aims to equip participants with the skills to build, evaluate, and deploy machine learning models using Python and R effectively. It balances theoretical knowledge with practical applications, ensuring that participants can apply machine learning concepts to solve real-world problems.
Abstract:	1. Introduction to Machine Learning: This provides an essential foundation in machine learning, covering its various types and the importance of ML in data analysis. 2. Data Preprocessing and Analysis: Focusing on the crucial steps of cleaning, transforming, and analyzing data in Python and R, this part is fundamental for preparing datasets for ML modeling. 3. Regression Analysis: Covering both simple linear and polynomial regression models along with multiple regression, to understand relationships within data. 4. Logistic Regression: Delving into logistic regression and its applications, including ROC analysis, essential for classification problems. 5-6. Unsupervised Learning Techniques: This section covers clustering and dimensionality reduction techniques, including k-means, hierarchical clustering, density-based clustering, and principal component analysis. 7-8. Supervised Learning Techniques: A detailed exploration of algorithms such as decision trees, random forests, and support vector machines, implemented in both Python and R. 9. Model Evaluation and Tuning: This part discusses methods for evaluating ML models and strategies to optimize their performance, focusing on the balance between overfitting and underfitting. 10-11. Advanced Topics in Machine Learning: Introducing more complex areas of ML, such as neural networks, deep learning, and reinforcement learning, with practical examples in Python and R. 12-13. Real-World Machine Learning Projects: Practical application of ML concepts through projects and case studies, leveraging Python and R in real-world scenarios.
Requirements on student/Prerequisites	Prerequisites: Basics of programming in Python and R

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Theory of Automata and Formal Languages***
Course code:	KI/EAFJ
ECTS:	7
Level of course:	Bachelor/Master
Teacher:	Doc. Ing. Mgr. Jiří Barilla, CSc.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	In this course, students will learn the theoretical foundations of finite automata, grammars and pushdown automata. Emphasis is placed on connecting mathematical theory with practical implementation and application of the theory to current technologies.
Abstract:	1. Finite Automata (KA): representations, languages recognizable by finite automata 2. Reduction and implementation of finite automata 3. Non-deterministic finite automata 4. Grammars: Chomsky's distribution of grammars, regular grammars 5. Regular languages: closure properties, relation to KA 6. Applications of regular languages and automata: regular expressions and their types 7. Context-free grammars 8. Pushdown automata 9. Applications of context-free languages and stack automata: LR/LL syntactic parser, ANTLR 10. Turing machines: models and their properties 11. Undecidability: the Church-Turing thesis, the Post correspondence problem 12. Equivalent representations of Turing machines: RASP 13. Practical applications
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Big Data Storage and Tools***
Course code:	KI/EBIG
ECTS:	7
Level of course:	Master
Teacher:	Mgr. Jiří Fišer, Ph.D., RNDr. Petr Kubera, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/4 per week
Completion:	Exam
Course goal:	The course is focused on the topic of processing large and rapidly growing volume of data through Hadoop technology or some types of NoSQL databases. The lectures cover the basic principles of distributed storage and distributed data processing, while the exercises focus on the implementation of sample examples. The introductory lectures are dedicated to the installation of individual software components and their cooperation with the use of virtualized containers.
Abstract:	1. Virtualization principles and tool overview 2. Creating unified environments (application isolation): Docker, CoreOS, rkt 3. Cluster architecture: an overview of Hadoop 4. Storage HDFS, HiveQL 5. MapReduce framework (principles) 6. Spark and its architecture 7. Spark modules: MLlib (machine learning), GraphX, Spark Streaming (data streaming) 8. - 9. NoSQL databases and BigData (MongoDB, Neo4j, Caché)
Requirements on student/ Prerequisites	Exam: preparation and oral defense of a seminar program that processes big data in a distributed system, verification of general factual knowledge Prerequisites: programming (Python or C or Matlab), relational databases

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Database Systems***
Course code:	KI/EDBS
ECTS:	9
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Ing. Mgr. Pavel Beránek
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/3 per week
Completion:	Exam
Course goal:	The course has two parts: 1) advanced relational databases optimization of SQL queries and server-side and client-side programming. 2) introduction to NoSQL database systems with a focus on their use in a highly distributed environment
Abstract:	Relational databases: 1. Nested SELECT subqueries and their (more efficient) alternatives (analytic functions, DISTINCT ON) 2. Index files and query analysis (efficient implementation of JOIN operation) 3. Full-text search 4. Recursive CTE and representation of hierarchies 5. SQL views and procedural extensions 6. Cursors 7. Triggers 8. DCL and user management 9. High-level client-side access (ORM) NoSQL: 1. Definition and objectives of NoSQL database systems 2. Scalability (vertical and horizontal), consistency issues (CAP theorem and BASE model) 3. Data distribution (sharding, replication) 4. Basic types of NoSQL database systems and their relations to relational database systems 3. Key-value databases (practical demonstration of REDIS) 4. Document-oriented database systems (Mongo, BJSON in PostgreSQL), pipelines, map-reduce 5. Graph-oriented database systems (Neo4J)
Requirements on student/Prerequisites	Exam: preparation and oral defense of a seminar work aimed at design, creation and pilot use of database (in both RDBMS and NoSQL database system), verification of general factual knowledge Prerequisites: basics of SQL and RDBMS (select, joins, transactions)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Object-Oriented Design Patterns***
Course code:	KI/EOONV
ECTS:	7
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Ing. Mgr. Pavel Beránek
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course deepens the practical skills of the programmer through the use of classical object-oriented design patterns in OOP language with static typing. The course begins with an introductory description of the C# language from the perspective of type system and the mechanism of controlled polymorphism. The core is then a description of the key classical design patterns (GoF) and their implementation in the chosen programming language.
Abstract:	1. type system in statically typed object-oriented programming languages 2. – 3. polymorphism based on a shared interface (protocol) 4. polymorphism based on inheritance (access specifiers) 5. design patterns (principles and goals) 6. – 7. generating design patterns (Factory methods and objects, Singleton) 8. – 9. structural design patterns (Adapter, Decorator, Bridge, Flyweight) 10. – 11. behavior-related patterns (Command, Observer, Memo) 12. – 13. design, discussion and initial implementation of the seminar project
Requirements on student/Prerequisites	Exam: sample application using appropriate design patterns Prerequisites: programming, basic principles of object-oriented programming (class, polymorphism)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Operating Systems Principles and Administration***
Course code:	KI/EOSY
ECTS:	7
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Ing. Pavel Kuba, Ph.D.,
Term:	Summer semester, Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	Lectures: The course is focused on basic principles of contemporary operating systems and on their internal structures, especially from the view of application programmers (i.e. at the level of kernel interface, e.g. POSIX and Win32). Exercises: Laboratory exercises are focused on gaining practical experience with administration of operating systems. The aim of this practically based course is to introduce students to the principles of the most widely used enterprise systems with emphasis on their reliability and security. The focus will be to understand and manage Microsoft Windows Server environment and Active Directory group policies.
Abstract:	Exercises: 1. Operating system architecture 2. Memory management 3. Memory virtualization 4. Shared memory 5. Task management (CPU scheduling) 6. Threading 7. Synchronization 8. Interprocess communication 9. I/O subsystem 10. File system 11. Operating system security 12. Operating systems and MIMD (SMP) Lectures: 1. Directory Services - an overview, history, function, safety aspects, LDAP 2. Active Directory - domains, organizational units, sites 3. Trees and forest, global catalog, DNS integration 4. Working with AD objects, ADSI, methods of administration 5. Methods of OS deployment, directory services and applications 6. The roles and functions of the server, terminal services, Internet Information Server 7. Network Services, DNS, DHCP, DirectAccess 8. Security and distribution groups, profiles, trusts, NTDSUTIL 9. Group Policy 10. Redundant Array of Independent Disks 11. PowerShell scripting environment 12. Methods of unattended installation
Requirements on student/Prerequisites	Credit: seminar work – deployment and configuration of OS Exam: oral (principles of OS) Prerequisites: practical usage and configuration experience with Linux or MS Windows

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Parallel Programming***
Course code:	KI/EPAR
ECTS:	7
Level of course:	Master
Teacher:	Mgr. Jiří Fišer, Ph.D., doc. RNDr. Zbyšek Posel, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course covers the use of parallelism including high performance computing. In addition to the necessary theoretical background, it focuses on the use of existing tools and libraries on the Python platform. The course includes both basic approaches to parallelism: systems with message passing (the multiprocessing module, classical MPI) and systems over shared memory (based on OpenMPI and CUDA). A key part of the course are exercises in which students can experience parallel programming not only on desktop computers and laptops with multiple cores, but also on the faculty computing cluster and on specialized hardware (currently Nvidia Jetson Nano).
Abstract:	1. - 2. Parallel hardware (Flynn taxonomy, loosely and tightly coupled systems, NUMA, SIMD support on AMD/Intel x86_64 platform, AMD, compute clusters, massive parallelism via GPGU) 3. Parallelism limitations (Amdahl's and Gustafson's law, memory organization, cache impact), parallelism from software perspective (asynchronous and concurrent programming, computational threads, data and task-oriented parallelism, memory sharing vs. message passing, synchronization usable for HPC tasks) 4. Module \`multiprocessing\`, parallel maps, explicit use of communication queues 5. - 6. MPI in Python (point-to-point communication, collective communication) 7. - 8. Parallelism over shared memory, OpenMP and its use in Python (Numba, Cython, C code integration) 9 - 11. Using the CUDA platform in Python (Numba Cuda, Python CUDA) 12 - 14. Modern approaches to HPC parallelism (e.g. parallelism in Julia, Intel oneAPI, content will be adapted to current trends)
Requirements on student/Prerequisites	Exam: preparation and oral defense of a seminar work aimed at implementation of a parallel version of a non-trivial algorithm using CPU and GPU, verification of general factual knowledge Prerequisites: programming (Python or C or Matlab)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Advanced Data Structures and Algorithms***
Course code:	KI/EPDSA
ECTS:	7
Level of course:	Master
Teacher:	prof. Sergii Babichev, DSc., Mgr. Jiří Fišer, Ph.D., doc. RNDr. Viktor Maškov, DrSc., RNDr. Jiří Škvor, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The lectures focus on the formal description of algorithms and examples of their application in practice. In the course of the exercises, individual algorithms are implemented or their implementation in standard libraries is discussed (comparison of implementation efficiency) and their practical use is suggested.
Abstract:	1. Theoretical foundations of algorithmization: asymptotic complexity (Landau asymptotic notation), locality principle (implications for caches) 2. Data structures: basic principles, linear data structures, hash tables (hash functions), sparse arrays 3. Data structures: tree structures (binary ordered trees, heaps), tree balancing 4. Data structures: graphs (Fibonacci heaps, weighted graphs) 5. Recursive algorithms: divide and conquer (quick sort, merge sort, closest pair of points) 6. Recursive algorithms: dynamic programming 7. Greedy algorithms: deterministic greedy algorithms (e.g., finding the skeleton of a graph) 8. Greedy algorithms: heuristics (the traveling salesman problem) 9. Probabilistic algorithms: pseudo-random number generators, randomized data structures and classical algorithms, Monte Carlo methods 10. Computational geometry: convex hull, Delaunay triangulation, Voronoi diagram 11. Computational geometry: BSP tree, quadtree/octree and R-tree, Minkowski sum and its applications 12. Cluster analysis: hierarchical clustering, density clustering (DBSCAN), centroid clustering (k means), graph algorithms (cliques) 13. Text processing (suffix trees, string distance, approximate pattern matching)
Requirements on student/Prerequisites	Credit: seminar work (implementation of a non-trivial data structure or algorithm) Exam: oral, focused on the practical use of algorithms and data structures in Python/R Prerequisites: basics of procedural programming (loops, procedures), elementary data types (numbers, string, booleans), principles of efficient data representation (hashes, binary trees)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Programming for Mobile Platforms***
Course code:	KI/EPMP
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	Exam
Course goal:	Course of programming on mobile platforms (i.e. smartphones, tablets) focuses on typical features of these platforms - prolonged life cycle, sandboxing, dynamic GUI and integration of hardware and software services. Specific platform may vary according to IT trends.
Abstract:	1) main principles 2) description of targeted platform 3) IDE and compilation chain 4) basic design patterns and idioms 5) application manifest and security 6) GUI principles 7) 2D graphics 8) internet services 9) geolocation 10) sensors 11) persistent storage and databases 12) preparation of seminar work
Requirements on student/Prerequisites	Exam: seminar work, implementation of a program for a mobile platform (topics to be agreed with the lecturer) Prerequisites: advanced programming (Java, C#), GUI programming

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***System Simulation***
Course code:	KI/ESYS
ECTS:	6
Level of course:	Master
Teacher:	Mgr. Jiří Fišer, Ph.D., doc. RNDr. Zbyšek Posel, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/3 per week
Completion:	Exam
Course goal:	The course is aimed at computer simulations used in a wide range of areas from economic and transport problems to simulations of biological or chemical processes. The lectures are focused on the presentation of existing tools including demonstrations of their use. Simple models of dynamical systems are designed and implemented on appropriate simulation platforms, and the results of the simulations are visualized and analyzed.
Abstract:	1. Introduction to computer simulations (types of simulations, simulation objectives, areas of application, modern trends) with emphasis on stochastic simulations and continuous and particle modelling of dynamic systems 2. Discrete event-driven simulation in SimPy (principles, basic object types, implementation using coroutines), practical simulation design, implementation and visualization 3. Commercial systems for discrete event simulation and visualization (Simio, SIMUL8, etc.) including real-time 3D simulation systems 4. Dynamical systems (their description, coupling, equilibrium and transient state, linear response of the system, etc.), basic methods for modelling the evolution of dynamical systems (systems of ordinary differential equations) 5. SimuPy, a Python-based tool for continuous modelling of dynamical systems (object definition, object constraints, solution methods, visualisation of results) 6. Practical solution of dynamical systems using SimuPy: physical or biological models 7. Dynamic modeling of particle systems, system descriptions (scales), methods and modern trends, parallelization, simulation packages and trajectory analysis using Python (e.g. LAMMPS, MDAnalysis, etc.) 8. Deterministic and stochastic modeling of simple and complex particle systems (computer models, methods, visualization) 9. Practical problem solving for modeling deterministic and stochastic particle systems
Requirements on student/Prerequisites	Exam: seminar work (implementation of a specified model and the visualization of the simulation results) + oral examination focusing on both practical and theoretical aspects of simulations Prerequisites: programming (Python)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Introduction to Relational Databases***
Course code:	KI/EURDB
ECTS:	5
Level of course:	Bachelor
Teacher:	Mgr. Jiří Fišer, Ph.D., Mgr. Květuše Sýkorová
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Exam
Course goal:	This course provides a practical introduction to the design and basic implementation of relational databases. Students will learn about the conceptual and logical design of relational databases (including representations of relationships) and the basics of SQL Exercises will focus on the conceptual design of sample databases.
Abstract:	1. Relational databases (principles) and relational database systems (overview and classification) 2. Principles of conceptual design (entities, attributes and relational relationships, ERD) 3. Candidate keys and database normalization (normal forms) 4. DDL – commands for working with tables (CREATE, ALTER, DROP, data types and integrity constraints) 5. DML -- commands for working with data (INSERT, UPDATE, DELETE) 6. Elementary SELECT statement (SELECT, FROM, WHERE, ORDER BY) 7. Relationships between tables and their representation 8. Internal joins (INNER JOIN) 9. OUTER JOIN and other types of joins 10. Grouping (GROUP BY, HAVING) and aggregation functions 11. Transactions 12. – 13. Basic programming access to databases
Requirements on student/Prerequisites	Exam: preparation and oral defense of a seminar work aimed at database design and its implementation, verification of general factual knowledge Prerequisites: basics of procedural programming (loops, procedures), elementary data types (numbers, string, booleans)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***IT Architecture and Infrastructure***
Course code:	KI/EAIT
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Jan Krejčí, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	Exam
Course goal:	The course focuses on the methods and standards used in planning IS/IT architecture and infrastructure. During the theoretical course, the student will learn about individual standards and established standards. In practical laboratory exercises, the student will go through the entire process of designing IT projects. In addition to the actual architecture planning, the student will learn about the actual infrastructure elements and their technologies.
Abstract:	1. IT and its life cycle 2. IT reliability 3. IT architecture 4. Computer network infrastructure 5. SANs and data warehouses 6. Virtual IT infrastructure 7. Project digitization and visualization 8. Design and optimization of IT architecture development (2 weeks) 9. Use of opensource (LinuxBased) system for centralized infrastructure monitoring (3 weeks) 10. Comprehensive IT project management
Requirements on student/Prerequisites	Exam: oral (based on a seminar paper on an approved topic of 15 standard pages, i.e. 15x1800 characters) Prerequisites: Basics of computer networks and cybersecurity

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Security Technologies***
Course code:	KI/EBTE
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Jan Krejčí, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Exam
Course goal:	The aim of the course is to familiarize students with security technologies used in the environment of corporate systems, their development, functions and implementation.
Abstract:	1. PKI infrastructure - basic axioms, digital signature, hash function, usage, digital certificate, certificate authority 2. Computer and data security - basic defensive/protective technologies, techniques, tools, methods, data lifecycle, data partitioning, data backup and disposal 3. Principles of data security and protection in the Internet environment 4. OpenSource (LinuxBased) L7 Firewall Systems (2 weeks) 5. OpenSource (LinuxBased) Infrastructure Security (4 weeks) 6. Introduction to hacking, passive vulnerability analysis 7.Active system testing and vulnerability exploitation (3 weeks)
Requirements on student/Prerequisites	Exam: laboratory task solution Prerequisites: basics of computer networks, cybersecurity and IT architectures

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Internet Technologies and Protocols***
Course code:	KI/EITP
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Jan Krejčí, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Exam
Course goal:	The course focuses on the application layer of TCP / IP model and its corresponding layers of the ISO/OSI reference model. Students in the lecture will become familiar with the most commonly used protocols and services on the Internet. Within the workshops, students will configure individual services and monitor computer communications, in which they will detect and analyze individual protocols and their packets.
Abstract:	1. Basic concepts, repetition of TCP / IP and reference model ISO / OSI 2. Description of the application layer and its functions 3. Transport layer protocols ISO / OSI - TCP, UDP 4. Records of relational layers ISO / OSI - PAP, SSL 5. Connecting to a remote console - TELNET, RSH, SSH 6. Connecting to a remote GUI - VNC, RDP 7. Sharing of data - FTP, NFS, SAMBA 8. Web services - HTTP, HTTPS 9. E-mail communication - POP3, SMTP, IMAP 10. Online Syndication - RSS, Atom 11. Protocol for real-time communication - IRC, Jabber 12. Configuration Protocol Network - BOOTP, DHCP, DNS 13. Protocols for transmission of multimedia and publishing - UPnP (DLNA), RTP, RSTP, RCTP"
Requirements on student/Prerequisites	Prerequisites: fundamentals of computer networks and protocols

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Computer Networks***
Course code:	KI/EPSE
ECTS:	7
Level of course:	Bachelor
Teacher:	RNDr. Jan Krejčí, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course focuses on layers L1, L2 and L3 of ISO / OSI reference model. The students will learn about the kinds of lectures transmission medium for data communication, active components in a computer network serving the switching and routing. In practical exercises they will try to model various tasks of routing protocols and routing, design of network addresses and their ranges, and not least the creation of virtual networks.
Abstract:	1. Fundamentals of Computer Networks and Protocols 2. Protocols in TCP/IP 3. Transmission media and connectivity 4. Addressing in networks (VLSM, CIDR) 5. Architecture of switches 6. Functions of L2 and L3 switches (STP, RSTP, MST) 7. Architecture of routers 8. Routing (static) and RIP routing protocol 9. Routing protocols EIGRP, OSPF 10. Routing in Wireless Networks 11. Solving problems in routing 12. Virtual networks and routing between them (VLAN, VPN) 13. Security of switches"
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Use of Robot Kits***
Course code:	KI/EROB
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Jan Krejčí, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	Exam
Course goal:	The aim of the course is to acquaint students in more detail with the use of LEGO Mindstorms robotic kits. They will deal with projects that require sophisticated design and programming using a kit and its control unit. Part of the course will be discussions about the possibility of using robotic kits in education and demonstration of the use of a robot as a means of teaching algorithms or basics of programming.
Abstract:	1) Introduction to LEGO Mindstorms, design and creation of the first robot. 2) LEGO Mindstorms programming environment. 3) Programming techniques: a) robot movement in space, b) use of input and output modules, c) sensor data processing, d) responses to different inputs, e) working with variables and constants, f) parallel processes. 4) Methods and activities developing algorithmic thinking using robotic kits. 5) Robotics in education, examples of LEGO Mindstorms activities.
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Information and Communication Technologies***
Course code:	KI/EIKT
ECTS:	8
Level of course:	Bachelor
Teacher:	Ing. Pavel Kuba, Ph.D.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/3 per week
Completion:	Exam
Course goal:	The course will provide students with competencies in areas, which could be used at work with computer and its administration. Students will acquire basic knowledge about ICT and will practice the use of the Office packages, operating system, and gain awareness of safety in the network, especially on the Internet. Competence in the area of software applied in the course will be practiced in seminary work. Students will also learn how to use the more advanced features of Office packages.
Abstract:	1. Safe use of information technology; safe behavior on the Internet with an emphasis on social networks; data backup, redundancy and security to ensure its confidentiality, integrity and availability; protection against unwanted software and attackers. Principles of operation and correct use of computer networks and terminal elements 2. Effective use of operating systems with an emphasis on the Windows system 3. Document sharing and circulation, document management and versioning systems, MS Sharepoint, MS365, GSuite. Team sites, web parts, Sharepoint lists, workflow 4. Document management and corporate content management, teamwork; resources for teamwork and time management 5. Local and cloud computer network services; web storage 6. Advanced text document processing; creation of comprehensive documents; revisions, references 7. Effective work with a spreadsheet 8. Data processing, pivot tables, conditional formatting, graphic representation of data 9. Other tools for creating professional graphs (e.g. GnuPlot, Origin, SigmaPlot) 10. Presentation of outputs; advanced work with a program for creating presentations 11. Use of modern tools for presentation (e.g. Skype, YouTube, use of a tablet or smartphone) 12. Editing of digital images (raster - Gimp and vector graphics - Inkscape)
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Computer Architecture***
Course code:	KI/EPCA
ECTS:	7
Level of course:	Bachelor
Teacher:	Ing. Pavel Kuba, Ph.D., Mgr. et Bc. Kamil Balín
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2 lectures per week and 9 exercise per term
Completion:	Exam
Course goal:	This course is a comprehensive course of computer hardware. Students will become familiar with the principles and technologies of individual design elements of computers IBM PC. Individual computer subsystems will be discussed with a focus on modern trends, basic and expanding computer components including I/O devices with regard to the expected development of the issue. The course is structured in such way that, after the theoretical lecture, the students have the opportunity to practically familiarize themselves with individual PC components as part of independent work in laboratory practices. The task of the practical part is to familiarize themself primarily with the hardware of the IBM PC type computer and its accessories in the form of solving laboratory tasks. Teaching takes place in laboratories in smaller groups and serves to practice the knowledge acquired in the lecture. The main task is the construction of several types of computer, their configuration, installation of basic software and solving possible hardware or software problems. Students will try diagnostics and basic measurement of electrical quantities.
Abstract:	1. PC development, computer generations, basic technical characteristics, main representatives, I/O devices. 2. Architecture of digital computers: types and importance of architectures, uses, principles. Construction: main components, types of computers, computer cases, noise and cooling, ergonomics. 3. Motherboard and bus architecture: motherboard, chipset and controller architectures (Northbridge, Southbridge). BIOS, UEFI. 4. Types and development of peripheral buses, data transmission in the computer system: basic division, standards, characteristics, use, comparison. 5. Basic terms from processor technology, microprocessor structure, socket, processor architecture (RISC, CISC). Arithmetic-logic unit, controller, flag register, advanced architectures. 6. Internal structure of microprocessors, instructions. Instruction set, machine cycle (pipelining, superscalar architecture). Addresses and addressing methods in real and protected mode. 7. Memories: general distribution, memory types, general parameters. Semiconductor memories of the ROM/RWM type: types, parameters, principle of operation, use. Memory modules: types and development. Buffers and caches: use, principles of operation. SSD: technology, principle of operation. 8. Physical structure of hard disks: construction, parameters, principle of reading and writing data encoding. Addressing sectors. Interface for communication with the environment, interface for connecting hard drives. RAID array: types, implementation, advantages.

	9. Logical structure of hard disks: MBR, disk partition. File system FAT and NTFS: principle of operation, advantages and disadvantages. 10. Optical discs: construction of CD/DVD/BD drives, principles, media. Data encoding and file systems. Magneto-optical discs: construction, physical principles, advantages and disadvantages. Other memory systems. 11. Display units and graphic subsystem: physical principle and scheme of CRT, types, parameters. Physical principle of LCD, cell diagram, types (TN, IPS, VA), parameters. Plasma and 3D technologies. OLED. Graphics adapter: GPU, graphics memory. Graphics pipeline. 12. Sound subsystem: sound recording, digitization, recording quality. Interface. Sound playback, FM synthesis, wave table synthesis, I/O interface. 13. Peripherals. I/O devices: keyboard, mouse, printers (types, principles of operation), scanner, touchpad. Interfaces for communication with the environment: parallel × serial interfaces, types, description, comparison (USB, DisplayPort, Thunderbolt, etc.). Content of exercises (includes work with the use of a virtual machine) Security, computer assembly design, OS installation and configuration, scripting/automation of activities, backup, RAID array Filling of laboratories 1. PC building, hardware type troubleshooting, PC maintenance 2. measurement of physical characteristics (voltage, current, power, etc.), diagnostics and testing
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Computer Graphics***
Course code:	KI/EPGR
ECTS:	5
Level of course:	Bachelor
Teacher:	Ing. Pavel Kuba, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The aim of the course is to expand students' knowledge in the field of multimedia, their recording, playback and transmission. Students will acquire basic knowledge about the theory and algorithms of 2D and 3D computer graphics. The students are introduced to the following topics: drawing 2D elements, image processing, modeling the 3D objects and rendering the scene. Exercises are used to validate the discussed algorithms in the programming.
Abstract:	1. Signal processing, antialiasing. Light and color models (RGB, CMYK, HSV, YCC). 2. Data compression. Types and compression algorithms. 3. Digital photography and image processing. Bitmap graphics. Formats. Video and audio recording and processing. File formats. 4. Drawing 2D elements; Bresenham algorithm. Area filling (scan-line fill algorithm, seed fill algorithm); clipping 5. Image editing; color space reduction, histogram 6. Noise reduction, sharpening, edge detection 7. Coordinate systems; geometric transformation, projections methods 8. Boundary, volumetric and procedural representation, solid modeling 9. Light and local illumination models 10. Shading methods (flat, Gouraud, Phong) 11. Problem of visibility, shadows (projection methods, shadow volume, depth buffering) 12. Textures 13. Radiance, rendering equation, radiosity 14. Global illumination models; ray tracing, photon maps
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***GUI Programming***
Course code:	KI/EGUI
ECTS:	7
Level of course:	Bachelor
Teacher:	RNDr. Petr Kubera, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The objective of this course is to initiate the students to the concept of visual programming and event driven programming.
Abstract:	1. Event driven programming, delegates, events, design pattern Observer 2. Visual design of application, working with forms, dialogs. 3. SDA, MDA application, collecting data from forms 4. Working with XML, serialization, SOAP 5. Globalization and localization 6. Working with databases 7. Multithreading, visual multithreaded application 8. Usage graphics libraries 9. Printing 10. User defined components 11. Reflection, plugins 12. Network applications
Requirements on student/Prerequisites	Prerequisites: Advanced knowledge of OOP (C# or Java or C++) or in Python

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Object Oriented Design***
Course code:	KI/EOON
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Petr Kubera, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Exam
Course goal:	This course is focused on object-oriented design and software analysis in UML. Students will become familiar with structural and behavioral view and appropriate UML diagrams. At the same time students will gain an overview of selected approaches and methodologies of software development.
Abstract:	1. Introduction into UML, overview of software 2. The basics building blocks of UML 3. Use case diagrams 4. Structural diagrams 5. Behavioral diagrams 6. Diagram of interactions 7. Software development approaches 8. Unified Process 9. Waterfall model 10. Prototype model 11. Extreme programming 12. Overview of another software development approaches
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Optimal Decision Making***
Course code:	KI/EOPR
ECTS:	7
Level of course:	Bachelor
Teacher:	RNDr. Petr Kubera, Ph.D., Dr. Hossein Moosaei
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	This course is focused on an introduction to optimal decision making. The topics covered in the course are: linear programming, projects management and scheduling methods and introduction to the queueing theory. As a problem base domain, examples from economy and informatics are taken. An integral part of the course is solving practical real-world problems with the use of appropriate software.
Abstract:	1. Linear programming (LP) formulation and mathematical properties. 2-4. Solution of LP problems: graphical method, primal simplex method, big M method, duality theory in linear programming (dual simplex method) 5-7. The transportation and the assignment problem, travelling salesman problem, formulation, methods of solving (MODI method, Hungarian method, TSP as LP problem) 8-9. Project management and scheduling: CPM and PERT method, cost slope analysis 10-11. Introduction to the queueing theory, Kendall's notation, M/M/1 and M/M/m models 12-13. Complex models: M/M/1/k and M/M/m/k and their applications
Requirements on student/Prerequisites	Exam: written test focused on solving examples together with seminar work and oral examination Prerequisites: Basics from linear algebra and analysis (differential calculus)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Operating Systems***
Course code:	KI/EOPS
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Petr Kubera, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/1 per week
Completion:	Exam
Course goal:	The course is targeted to the basic principles of contemporary operating systems and to its internal structure, especially it is focussed on the Linux/UNIX systems. The topics covered in this course are working with shells, programming scripts, system configuration and administration.
Abstract:	1. OS architecture: file systems, users, processes, 2. Introduction to the system shells, working with files and directories 3. Introduction to file systems, structure, classification, properties, physical and logical volumes 4. Users and groups, permissions, management 5. Process management, priorities, signals, interprocess communication 6. Tools for text processing, pipes 7. Introduction to the scripting, conditionals, loops 8. System services, principles of services configuration 9. Network services and configurations (address, ports, web server, ssh server, mail server) 10. Network file systems 11. System software management, building programs, software packages and package managers 12. Data and system archiving management
Requirements on student/Prerequisites	

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Optimization***
Course code:	KI/EOTT
ECTS:	7
Level of course:	Master
Teacher:	RNDr. Petr Kubera, Ph.D., doc. Ing. Mgr. Jiří Barilla, CSc., Dr. Hossein Moosaei, PhD
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Credit, Exam
Course goal:	This course provides an overview of selected optimization techniques. We emphasise continuous optimization methods and methods used in machine learning algorithms and neural networks. An integral part of the course is also own implementation of algorithms and solving practical problems using appropriate software.
Abstract:	1. Optimization problems and common tasks: free and constrained optimizations, discrete vs continuous problems, multicriterial optimization, examples. 2. The computing of derivatives and gradients: numerical and symbolical derivative, automatic differentiation. 3. Minimization in 1D: (quadratic interpolation method, golden cut method, Fibonacci numbers method) 4 - 5. First order methods: gradient method, conjugate gradient method, Nesterov type method, Adagrad and RMS method. 6. Second order methods: Newton method, Quasi-Newton methods 7. The least squares method: formulation (curve fitting, regression), linear, nonlinear, Levenberg-Marquardt algorithm. 8. Non-derivative methods: method of Hook-Jeeves, Powell's and Nelder-Mead method 9 - 10. Basic principles of stochastic and population method: simulated annealing, particle swarm method, firefly method, cuckoo method 11-12. Constrained problems: Lagrange multiplier method, KKT conditions, duality, principles of penalty methods 13-14. Quadratic programming: formulation, principles of solutions and selected application - SVM
Requirements on student/Prerequisites	Prerequisites: Linear algebra and differential calculus

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Advanced Numerical Methods***
Course code:	KI/EPNUM
ECTS:	8
Level of course:	Master
Teacher:	RNDr. Petr Kubera, Ph.D., RNDr. Jiří Škvor, Ph.D., doc. Ing. Mgr. Jiří Barilla, CSc.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Credit, Exam
Course goal:	This course is an extension of the basic course of numerical methods with respect to numerical linear algebra and parts used in machine learning.
Abstract:	1. Sources of numerical errors, the numerical stability of algorithms 2-3. System of linear equations, conditional number, Gaussian elimination LU factorization, Cholesky and QR factorization 4-5. Iterative methods for the solution of linear algebraic equations: Jacobi method, Gauss-Seidel method, SOR, steepest descent method and conjugate gradient method. 6-7. Eigenvalues of the matrix: partial eigenvalues problem - power method, full eigenvalues problem QR iteration 8. Singular Value Decomposition – SVD: computation and applications 9. Method for nonlinear equations, Newton's (Newton-Rhapson) method, fixed point method, etc. 10. Root finding for polynomials, Horner scheme 11. Principles of numerical quadrature: Newton-Cotes rules, Romberg's quadrature method, Gaussian quadrature rules, MC and adaptive methods 12. Principles of numerical solution of ODEs: one-step methods, Runge-Kutta methods, stiff system, stability, etc. 13. Function interpolation and approximation: Lagrange interpolation, cubic spline interpolation, Chebychev approximation
Requirements on student/Prerequisites	Prerequisites: Basics from linear algebra (vectors, matrices, vector spaces) and analysis and basic principles of numerical method

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Introduction to Machine Learning***
Course code:	KI/EUSU
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Petr Kubera, Ph.D.,
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Credit, Exam
Course goal:	This course presents a practical introduction to data processing and analysis via machine learning. We are focused on a basic understanding of the principles of the methods and we emphasise the practical application of the methods. The relevant frameworks in the Python language (Scikit-learn, TensorFlow, Keras, CVXOPT) are used.
Abstract:	1. Division of machine learning tasks 2. Data classification, types of classifiers 3. Preparation of data and datasets: replacement of missing data, work with categorical data 4. Issues of data dimensionality and methods of its reduction 5 Decision trees (types of metrics, construction) 6. Linear classification, linear separability, linear perceptron and its learning, logistic regression 7. Support vector machines (SVM): problem formulation, SVM as an optimization task 8. Method of support vectors: soft-margin issue, dual SVM formulation, solution using quadratic programming, SMO algorithm 9. Method of support vectors: kernel transformations, types of kernels 10. Neural networks: types of networks, network learning, activation functions 11. Neural networks: nonlinear multilayer perceptron (MLP) and its properties, backpropagation algorithm 12-13. Deep learning: basic principles (convolution, pooling) and practical use of frameworks 14. Evaluation of seminar work and discussion
Requirements on student/Prerequisites	Prerequisites: Basics from linear algebra (vectors, matrices, vector spaces) and analysis and basics of Python

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Dependability of Information Systems***
Course code:	KI/EDEP
ECTS:	5
Level of course:	Bachelor
Teacher:	doc. RNDr. Viktor Maškov, DrSc.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/1 per week
Completion:	Exam
Course goal:	The course gives introduction into the problem of dependability of information systems. The issues of self-checking and self-diagnosis of computing systems will be explained in details during the given course. The main subject of the course focuses on the tasks of reliability and fault-tolerance of information system.
Abstract:	1. Introduction to the problems of dependability 2. Fault-tolerance of information systems 3. Techniques for providing fault-tolerance of information systems 4. Self-checking and self-diagnosis at system level 5. N-variant programming and object oriented programming 6. Exception handling in N-variant programming 7. Competing and cooperative concurrent systems 8. Conversation in distributed systems 9. Coordinated atomic actions 10. Dependability of distributed applications 11. Using groups of objects for providing fault-tolerance of complex systems 12. Dependability concepts with respect to malicious faults
Requirements on student/Prerequisites	Exam: oral

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Internet Programming***
Course code:	KI/EPIN
ECTS:	7
Level of course:	Bachelor
Teacher:	doc. RNDr. Viktor Maškov, DrSc.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	The course focuses on the basics of XML technologies. More attention will be given to the development of XML files and to the XML Schema. While studying the course, the students will develop your own XML applications. All the described technologies are the standards of W3C organization. It is assumed that students are already acquainted with basics of markup language XHTML, stylesheet CSS and protocols TCP/IP, HTTP which are needed to understand the issues of the course.
Abstract:	1. Basic Internet technologies and protocols 2. Markup language XML 3. XML – namespaces 4. XML / DTD (definition of legal elements of XML file) 5. DTD - directives "INCLUDE" and "IGNORE" 6. XML - Schema (XSD: elements, attributes, facets) 7. XML - Schema (XSD: indicators, element substitution, data types) 8. XML (stylesheet CSS) 9. XML and XSLT 10. DOM XML 11. xPath 12. Using xPath (XSLT, DOM XML)
Requirements on student/Prerequisites	Exam: oral

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Soft Computing***
Course code:	KI/ESOC
ECTS:	8
Level of course:	Master
Teacher:	doc. RNDr. Viktor Maškov, DrSc., RNDr. Petr Kubera, Ph.D., Ing. Mgr. Pavel Beránek
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	Exam
Course goal:	This course is focused on selected parts of Soft Computing, such as fuzzy logic and selected machine learning models (decision trees, support vector machines, neural networks and Bayesian networks). It provides both the theoretical background, as well as a practical introduction to currently used frameworks and libraries (Python). The lectures are focused on theoretical analysis and the domain of possible application. The exercises are focused both on the own design and implementation of algorithms, as well as on the transfer of practical experience in the use of software tools.
Abstract:	1. Overview of machine learning tasks: classification, regression, prediction and areas of application 2. Decision trees: construction, metrics 3. - 4. Support vector method (SVM): formulation, soft margin formulation, solution, use of kernels, kernel trick, classification into multiple classes 5. Introduction to neural networks: types of networks and their architecture, types of learning 6. - 7. Networks of the multilayer perceptron (MLP) type: perceptron, activation functions and their types, layers and learning, relearning, regularization 8. Feedback learning: use and overview of algorithms with a focus on Q-learning 9. Machine learning meta-algorithms: clustering of weak classifiers, random forests, boosting, AdaBoost 10. Fuzzy set: introduction, properties (domain of values, height, carrier, kernel), cuts, membership 11. Fuzzy sets and their extensions: an overview of set and propositional operations and their properties, fuzzy numbers and fuzzy relations 12. Use of fuzzy logic: fuzzification and defuzzification process, linguistic variables 13. Bayesian statistics: definition of basic terms (distribution, prior, posterior), Bayes theorem and its use 14. Bayesian networks (BN): graph representation, model probability distribution (chain rule), an overview of BN learning algorithms
Requirements on student/Prerequisites	Prerequisites: Basics from linear algebra (vectors, matrices, vector spaces), calculus and basics of Python

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Software Engineering***
Course code:	KI/ESWI
ECTS:	5
Level of course:	Bachelor
Teacher:	doc. RNDr. Viktor Maškov, DrSc., Mgr. Ing. Pavel Beránek
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	Exam
Course goal:	The course focuses on the basics of software engineering. More attention is given to the problem of developing of reliable and fault-tolerant software systems. Modern formal methods for developing reliable SW are considered with the examples.
Abstract:	1. Basics of SW engineering 2. Software processes 3. SW verification 4. SW validation 5. SW reliability 6. Models of SW reliability 7. Diagnosis of SW 8. Architectures of fault-tolerant SW 9. Distributed systems 10. Diagnosis model of a SW system. Comparators and consistent set of units 11. Concurrency (competition and cooperation) 12. Coordinated atomic actions 13. Formal methods for developing a reliable SW.
Requirements on student/Prerequisites	Exam: oral

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Optimization for Machine Learning with MATLAB***
Course code:	KI/EOMLM
ECTS:	5
Level of course:	Bachelor
Teacher:	Dr. Hossein Moosaei, PhD
Term:	Summer semester, Winter semester
Language of instruction:	English
Lectures/exercises:	2/1 per week
Completion:	Exam
Course goal:	This course teaches an overview of optimization methods, for applications in machine learning and data science by using MATLAB. Indeed, Optimization for Machine Learning with MATLAB provides an insight into the theory background and applications of supervised and unsupervised learning algorithms in MATLAB. MATLAB is one of the best tools for assignments and course projects, but if you have other preferences, you can use different suitable environments, such as Python.
Abstract:	1. Introduction to Optimization (Convex sets, convex functions, and unconstrained and constrained optimization problems) 2. Optimality Conditions for Unconstrained and Constrained Optimization 3. Duality Theory 4. Optimization Techniques in MATLAB 5. Introduction to Data Representation and Mining 6. Support Vector Machines 7. Proximal Support Vector Machines 8. Twin Support Vector Machines 9. Clustering by k-means 10. Validation Methods 11. Machine Learning with MATLAB 12. Massive Data Sets and Future Challenges
Requirements on student/Prerequisites	Exam: project assignment Prerequisites: Programming language (MATLAB or Python)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Mathematical Software***
Course code:	KI/EMSW
ECTS:	5
Level of course:	Bachelor
Teacher:	doc. RNDr. Zbyšek Posel, Ph.D., Ing. Pavel Kuba, Ph.D., Mgr. Ing. Pavel Beránek
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	0/2 per week
Completion:	Exam
Course goal:	The course is focused on the introduction of the basic mathematical packages in Python, such as Numpy, SciPy etc. The emphasis is put on the solution of problems of calculus, algebra and numerical mathematics.
Abstract:	1. Basic mathematical operations in Python (math, cmath, fractions, decimal etc.) 2. Modules for mathematical manipulations and calculations (NumPy, SymPy) 3. Data visualization (PyPlot, PyQtGraph) 4. Basics of Linear algebra (direct and iterative methods) 5. Approximation and interpolation 6. Finding roots of equations 7. Seminar work no. 1 8. Random number generation and testing of generators 9. Monte Carlo methods 10. Calculus – derivate 11. Calculus – integration 12. Ordinary differential equations (two weeks) 13. Seminar work no. 2
Requirements on student/Prerequisites	Prerequisites: Procedural programming (loops, procedures function)

Faculty/Institute:	**Faculty of Science / Department of Informatics**
Course title:	***Python and R for Data Science***
Course code:	KI/EPYR
ECTS:	6
Level of course:	Master
Teacher:	RNDr. Jiří Škvára, Ph.D., RNDr. Jiří Škvor, Ph.D., prof. Sergii Babichev, DSc.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	Exam
Course goal:	In the course, students will practically develop basic skills in programming languages Python and R in key areas for data engineers and scientists. Students will learn various methods and techniques of data processing, analysis and visualization purely practically on model solutions, i.e. at the application and interpretation level, without the need for deeper knowledge of the principles of these methods and techniques, which should be acquired in previous or next study. A significant part of the teaching is the work of students in groups on solving case studies ("inspired by data") of a smaller scale, their presentation and mutual critical evaluation. Kaggle.com platforms are the source of data and inspiration. The materials of teaching platforms such as datacamp.com will be used in teaching, which are otherwise recommended especially for self-study and obtaining certificates.
Abstract:	1. Deepening the basics of syntax and basic constructions of Python and R languages 2. Basics of data manipulation and visualization 3. Intermediate data and data file manipulation (import, cleaning, etc.) 4. Intermediate data visualization 5. - 6. Exploratory analysis, selected advanced statistical methods (correlation, regression, factor, cluster analysis, etc.), inference statistics 7. - 8. Introduction to machine learning (selected classifiers, regression and clustering algorithms) 9. Introduction to natural language processing, sentiment analysis 10. Network analysis 11. - 12. Reports, dashboards and interactive data visualization 13. Summary, discussion on the assignment of seminar works
Requirements on student/Prerequisites	Exam: preparation and oral defense of a seminar work aimed at data processing, exploratory analysis and machine learning, verification of general factual knowledge Prerequisites: Basics of programming in Python and R, basic knowledge of soft computing

DEPARTMENT OF MATHEMATICS

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Advanced statistical methods***
Course code:	KMA/E101
ECTS:	5
Level of course:	master
Teacher:	Mgr. Alena Černíková, MSc., Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	EXAM
Course goal:	The course aims at equipping students with advanced statistical methods applicable in descriptions of natural and socioeconomic phenomena. The course deepens the grasp of linear regression by extending it fully to the multivariate case and reviewing diagnostics and advanced topics that arise in modelling. The course then summarizes basic multivariate statistical methods and gives an introduction to generalized linear models. Finally, the course makes a brief overview of Bayesian statistical analysis and contrasts it with classical (i.e. non-Bayesian) statistics. The ambition is to imprint on students an understanding of statistical thinking. Students are expected to gain practical skills by working with data in program R.
Abstract:	1. Multivariate linear regression, diagnostics, transformations and advanced issues in regression modelling. 2. Methods of dimension reduction: principal component analysis, factor analysis. 3. Methods of classification: discriminant analysis, logistic regression. 4. Generalized linear regression models, diagnostics. 5. Bayesian methods: concepts, introduction to Bayesian inference, Bayesian linear regression.
Requirements on student/Prerequisites	Good knowledge of basic statistics is prerequisite for this course.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Game Theory***
Course code:	KMA/E103
ECTS:	5
Level of course:	bachelor
Teacher:	RNDr. Veronika Pitrová, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The student will learn the basics of game theory.
Abstract:	1. Definition of a game, basic notions. 2. Two-player games (bimatrix games, mixed strategies, Nash's theorem, optimal points of the game). 3. Two-player zero-sum games (matrix games, mixed strategies, fundamental theorem on matrix games, graphical solution of 2×n matrix games, general solution of matrix games – linear programming). 4. Two-player cooperative games (joint strategy, cooperative payoff region, bargaining problem). 5. n-player cooperative games (coalitions, characteristic function games, imputation, core). 6. Power indices (Shapley value, Banzhaf index).

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Mathematical Analysis I***
Course code:	KMA/E104
ECTS:	8
Level of course:	Bachelor
Teacher:	doc. Yaroslav Bazaikin, DrSc.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	3/2 per week
Completion:	EXAM
Course goal:	Students will learn basic concepts of mathematical analysis, mainly precise definitions of continuity, limits and derivatives. They will also learn how to use those tools in other fields, as physics, economy, and in mathematics (graphing functions, approximation by polynomial functions).
Abstract:	1. Real numbers and their properties, suprema and infima, sequences. 2. Limits of sequences, their basic properties. 3. Calculus of limits of sequences. 4. Series of real numbers, their convergence, criteria of series of positive numbers. 5. Series of sign changing numbers, absolute and non-absolute convergence. 6. Continuity of functions and its properties. 7. Basic theorems on continuous functions. 8. Limits of functions. 9. Derivative of functions and its properties. 10. Mean value theorem and its consequences. 11. Derivatives versus monotonicity, convex functions. 12. Applications of derivatives, graphing functions. 13. Aproximation by polynomial functions, Taylor polynomials.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Mathematical Analysis II***
Course code:	KMA/E105
ECTS:	6
Level of course:	Bachelor
Teacher:	doc. Yaroslav Bazaikin, DrSc.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Students will learn calculus of integration of real-valued functions of one variable and its applications in geometry and physics. They will also learn basic facts about ordinary differential equations.
Abstract:	1. Primitive functions (antiderivatives) and their basic properties. 2. Integration by parts and substitutions. 3. Integration of rational functions and of functions transformed to them. 4. Newton integral and his basic properties. 5. Riemann integral and its relation to Newton integral. 6. Numerical approach to integrals. 7. Application of integrals in geometry (surfaces, volumes, lengths). 8. Application of integrals in physics (centers of mass, work). 9. Ordinary differential equations of 1st order. 10. Ordinary differential equations of 2nd order. 11. Applications of differential equations.
Requirements on student/Prerequisites	Good knowledge of differential calculus of functions of one variable is required.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Mathematical Analysis III***
Course code:	KMA/E106
ECTS:	5
Level of course:	bachelor, master
Teacher:	RNDr. Veronika Pitrová, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Theory of differential and integral analysis of functions of more variables, their usage in geometry and physics. Function series, their convergence, derivatives and integration, power series.
Abstract:	1. Continuity and limits of functions of more variables. 2. Deeper properties of partial derivatives, gradient. 3. Implicit functions and their derivatives. 4. Extrema of functions of more variables. 5. Extrema of functions of more variables (constrained). 6. Integration of functions of more variables. 7. Riemann approach, relations to measures, other integrals. 8. Regular mapping, substitution in integrals of functions of more variables. 9. Application of integration of functions of more variables in geometry and in physics. 10. Function series, uniform convergence. 11. Derivative and integration of function series. 12. Power series.
Requirements on student/Prerequisites	Good knowledge of differential and integral calculus of functions of one variable is required.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Mathematical Analysis IV***
Course code:	KMA/E107
ECTS:	5
Level of course:	bachelor, master
Teacher:	RNDr. Veronika Pitrová, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Line and surface integrals and their applications, Fourier series and their calculus, Laplace and Fourier transform, calculus of variations.
Abstract:	1. Curves and surfaces. 2. Line integrals. 3. Green theorem. 4. Surface integrals. 5. Gauss-Ostrogradsky theorem. 6. Stokes theorem. 7. Potentials, applications to physics. 8. Fourier series. 9. Fourier integral and transform. 10. Laplace transform. 11. Calculus of variations, fixed end points problems. 12. Free end points problems.
Requirements on student/Prerequisites	Good knowledge of differential and integral calculus of functions of more variables is required.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Ordinary differential equations***
Course code:	KMA/E108
ECTS:	6
Level of course:	Bachelors
Teacher:	RNDr. Veronika Pitrová, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Students will learn the basic topics of the theory of ordinary differential equations, the most important classes and methods for solving of differential equations. In the theoretical part, the existence and uniqueness theorem for non-linear equation and the conversion of the equation of the nth order to the system of the first order equations are included. Further, linear equations and systems of linear equations of the first order will be investigated. Methods of solving equations with separable variables, linear equations and systems of linear equations with constant coefficients, inclusive of variation of constants method, are involved.
Abstract:	1. Basic definitions - definition of the solution, general, particular, singular solutions, field of directions, Cauchy problem, boundary-value problem for differential equations. 2. Systems of nonlinear differential equations of the first order, conversion of one equation of the nth order to the system of the first order equations, Cauchy problem for systems of differential equations, existence and uniqueness of the solution, local and global properties. 3. Elementary methods for solving differential equations - equations with separable variables, homogeneous equations and some other types of the first order equations. 4. Linear equations of the first order - existence and uniqueness of the solution, solution to homogeneous and non-homogeneous equations, the formula for variation of constants. 5. Systems of linear equations of the first order - existence and uniqueness of the solution, fundamental solution matrix, the formula for variation of constants, systems of linear equations of the first order with constant coefficients. 6. Linear equations of the nth order, conversion to the systems of the first order linear equations, fundamental system of solutions, Wronskian, equations with constant coefficients, particular solution for special form of right-hand sides.
Requirements on student/Prerequisites	Good knowledge of differential and integral calculus of functions of one variable is required.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Probability and Statistics***
Course code:	KMA/E109
ECTS:	6
Level of course:	Bachelor
Teacher:	doc. Mgr. Ing. Martin Boďa, PhD.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The course aims at equipping students with basic notions of probability theory and mathematical statistics applicable in descriptions of natural and socioeconomic phenomena. The course begins with an elementary introduction into univariate and multivariate descriptive statistics, then makes through a selective overview of probability theory, and finalizes with basic introduction into inferential statistics. The ambition is to imprint on students an understanding of statistical thinking. Students are expected to gain practical skills by working with data in a suitable statistical software package (Microsoft Excel, R).
Abstract:	1. Descriptive statistics for univariate and multivariate data: measures of central tendency, dispersion, correlation and dependence. 2. Exploratory data analysis: visual display of quantitative data. 3. Theory of random variables and probability laws. 4. Discrete probability distributions, their properties and applications. 5. Continuous probability distributions, their properties and applications. 6. Laws of large numbers, central limit theorem. 7. Concepts of inferential statistics, theory of random sample. 8. Point and confidence estimation of univariate parameters. 9. Testing of hypotheses of univariate parameters: parametric and non-parametric approaches.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Problem Solving Methods for Mathematics***
Course code:	KMA/E110
ECTS:	5
Level of course:	Bachelor
Teacher:	RNDr. Veronika Pitrová, Ph.D
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The course further develops the student's competence in the field of the formulation and the solution of mathematical exercises, problems and problem situations. Attention is paid to independently solving various types of exercises, to choosing appropriate strategies, to taking advantage of knowledge from various mathematical disciplines, to using computers. Students will learn inductive procedures, induction, generalization and stating hypotheses, deduction and proofs, further parametrical exercises, discussion about the number of solutions.
Abstract:	1. Problems, history. 2-6. Strategies of problem solving (analogy, generalization, specialization, algebraic way, geometric way, and so on). 7-10. Method of generated problems. 11-12. Investigation of mathematical situations, models of non-mathematical situations.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Time Series***
Course code:	KMA/E111
ECTS:	5
Level of course:	Master
Teacher:	doc. Mgr. Ing. Martin Boďa, PhD.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	EXAM
Course goal:	The course seeks to acquaint students with the main concepts of modern time series theory universally applicable in describing the passage of natural and socioeconomic phenomena. Students will master methods of forecasting and analysis of time series based on the Box-Jenkins methodology of ARMA (p,d,q) models. They will understand difficulties associated with non-stationarity, and will learn methods how to tackle its presence. Finally, students will learn the pitfalls of running regressions with non-stationary time series. The course emphasises building of practical skill when working with real-world data in program R.
Abstract:	1. Stochastic processes and their main characteristics. Stationary stochastic processes. Wold decomposition. 2. Moving average models MA(q). Condition of invertibility. Autoregressive models AR(p). Yull-Worker equations. Stationarity conditions. Autoregressive-moving average models ARMA(p,q). 3. Coefficient estimation in ARMA (p,q) processes. Box-Jenkins methodology to identification of stationary time series models. 4. Forecasting, trend and seasonality in the framework of the Box-Jenkins model 5. Non-stationary time series. Time series with non-stationary variance, non-stationary mean. ARIMA (p,d,q) models. The use of Box-Jenkins methodology to determination of order of integration. 6. The unit root problem. Spurious trends and regressions. Unit root tests. 7. Unit root and structural changes. Non-stationary time series, trend stationarity versus difference stationarity. 8. Regressive dynamic models. Autoregressive models with distributed lags (ARDL).
Requirements on student/Prerequisites	Good knowledge of statistics is prerequisite for this course.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Topology***
Course code:	KMA/E112
ECTS:	6
Level of course:	bachelor, master
Teacher:	RNDr. Veronika Pitrová, Ph.D.
Term:	Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Students will learn basic concepts of topology – basic constructions, separation axioms, compactness, metrizability, functions spaces.
Abstract:	1. Basic notions (open and closed subsets, continuity). 2. Basic constructions (subspaces, products, sums, quotients). 3. Separation axioms. 4. Compact spaces. 5. Compactifications. 6. Generalizations of compactness. 7. Normal spaces, Urysohn's lemma. 8. Metrizability. 9. Functions spaces. 10. Stone-Weierstrass theorem. 11. Brouwer's fixed-point theorem. 12. Topological groups.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Linear algebra***
Course code:	KMA/E113
ECTS:	5
Level of course:	Bachelor
Teacher:	PhDr. Jiří Přibyl, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	Students will learn basic concepts of linear algebra – vector spaces, matrices, systems of linear equations.
Abstract:	1. Fields, vector spaces 2. Matrices 3. Systems of linear equations (matrix representation, Gauss-Jordan elimination) 4. Linear combinations (linear span, vector subspaces, linear independence, rank of a matrix) 5. Basis and dimension (finite dimensional vector spaces, Steinitz exchange lemma, coordinates of a vector with respect to a given basis) 6. Linear transformations (homomorphism, isomorphism, kernel, matrix of a linear transformation) 7. Inverse matrix (calculating the inverse matrix, change of basis matrix) 8. Determinants (definition, basic properties, Laplace expansion, calculating the determinant, inverse matrix, Cramer's rule) 9. Eigenvalues and eigenvectors, characteristic polynomial

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Geometry***
Course code:	KMA/E114
ECTS:	6
Level of course:	bachelor, master
Teacher:	PhDr. Jiří Přibyl, Ph.D.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The student will gain a basic idea of mappings of affine and Euclidean spaces. The course concludes with a brief introduction to the theory of conic sections.
Abstract:	1. Affine mappings - definition, properties, invariants - the Affine group - equations of affinities - a classification of affinities 2. Mappings of Euclidean spaces - isometries of Euclidean spaces - similarities of Euclidean spaces - equations of mappings - classification of isometries of 1D and 2D Euclidean spaces 3. Conic sections - definition, properties - classification - transformation of conic sections
Requirements on student/Prerequisites	This course is suitable for students at least a second year of study of a bachelor degree. It is expected that the student has completed a course of linear algebra (undergraduate level) or analytic geometry (undergraduate level).

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Introduction to the Didactics of Mathematics in Teachers Education***
Course code:	KMA/E115
ECTS:	6
Level of course:	Bachelor
Teacher:	PhDr. Magdalena Krátká, Ph. D.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	1/2 per week
Completion:	EXAM
Course goal:	Students will get acquainted with the basic procedural basis of teaching mathematics and the connection of mathematics as a field of epistemological and didactic point of view. By analyzing specific model situations and case studies, they will develop their ability to observe, analyze and influence the teaching process.
Abstract:	1. Didactics and Mathematics: Mathematics as a scientific field 2. Didactics of mathematics focused on a curriculum content, and didactics of mathematics focused on pupil´s cognitive; Goals of teaching mathematics 3. Inductive and deductive principles 4. The language of mathematics 5. Hypothesis, proofs and illustrations 6. Metacognition in teaching of mathematics 7. Interdisciplinary context (for example between algebra and geometry) 8. Interdisciplinarity and development of mathematical competition 9. Mathematical problem 10. Solving process of a mathematical problem 11. Heuristic strategies 12. Activation methods of teaching mathematics

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Introduction to analytic geometry***
Course code:	KMA/E117
ECTS:	6
Level of course:	bachelor
Teacher:	PhDr. Jiří Přibyl, Ph.D.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The student will gain a basic idea of affine and Euclidean spaces.
Abstract:	1. Affine spaces - definition, dimension, properties, examples - linear varieties - definition, dimension, properties, examples - affine and barycentric coordinates - affine frames - equation of linear variety - simple ratio - theorems of Thales, Menelaos and Ceva 2. Euclidean affine spaces - definition, properties, subspaces - orthogonality - metrics
Requirements on student/Prerequisites	This course is suitable for all undergraduate students (math study programme). A basic knowledge of linear algebra (at the undergraduate level) is expected but not required.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Differential Geometry***
Course code:	KMA/E118
ECTS:	6
Level of course:	bachelor
Teacher:	doc. Yaroslav Bazaikin, DrSc.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The aim of the course is to introduce students to the basic ideas and methods of differential geometry of curves and surfaces, which underlie all modern differential geometry. A feature of the course is the study of the global geometry of surfaces: the elements of topology and the relationship between topological and differential-geometric properties of surfaces are presented.
Abstract:	1. Plane curves: curvature, natural equation. Four vertexes theorem. Isoperimetric inequality. Crofton formula. Space curves: curvature and torsion. 2. Local Differential Geometry of surfaces: first and second fundamental forms, principal curvatures, Meusnier's Theorem, Christoffel symbols, Weingarten equations, Gauss-Codazzi equations, Bonnet Theorem. Gaussian curvature, mean curvature. 3. Parallel transportation along the curve, geodesics. Extremal properties of geodesics. Elements of variational calculus of geodesics. Integrability of geodesic flow. 4. Area. Minimal surfaces, mean curvature. Examples of minimal surfaces. 5. Degree of map: definition, homotopy invariance, examples. Degree of Gauss map of surface. 6. Triangulation. Euler characteristics. Gauss-Bonnet formula for surface homeomorphic to disc. Gauss-Bonnet theorem for closed surface. Invariance of Euler characteristic of closed surface. 7. Topological classification of closed surfaces, genus.
Requirements on student/Prerequisites	Knowledge of basic concepts of linear algebra, elementary calculus and ODE is prerequisite for this course.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Computational Topology***
Course code:	KMA/E119
ECTS:	6
Level of course:	master
Teacher:	doc. Yaroslav Bazaikin, DrSc.
Term:	Winter semester, Summer semester
Language of instruction:	English
Lectures/exercises:	2/2 per week
Completion:	EXAM
Course goal:	The aim of the course is to introduce students to the modern field, located at the intersection of topology and computer science. In many applied problems (in geophysics, chemistry, medicine, biology, etc.) there is a need for a qualitative analysis related to the global behavior of the objects included in the system. Topology methods turn out to be an indispensable tool. At the same time, the problem of creating computationally efficient algorithms for calculating topological characteristics becomes very important and this is one of the main objectives of course.
Abstract:	1. Elementary topology: topological spaces, homeomorphisms, connectivity, homotopy, homotopy equivalence. 2. Simplicial complexes: polyhedrons, abstract simplicial complex, Czech complex, Vietoris-Rips complex. 3. Simplicial homology: chain complex, boundary operator, homology. Invariance, Euler characteristics. Exact sequences. Betti numbers. 4. Algorithm of computation of Betti numbers. Important cases: algorithms of computation of zero Betti number; algorithm of computation of Betti numbers of homology of 2D and 3D simplicial complexes. 5.Morse theory, discrete Morse theory, Morse-Smale complex. 6. Persistent topology: filtration, persistent homology groups, persistent diagram, barcodes. Algorithm of computation of persistent diagrams. 7. Stability of persistent doagrams. 8. Various applications of computational topology.
Requirements on student/Prerequisites	Knowledge of basic concepts of linear algebra and algorithms is prerequisite for this course.

Faculty/Institute:	**Faculty of Science / Department of Mathematics**
Course title:	***Abstract Algebra***
Course code:	KMA/E120
ECTS:	5
Level of course:	bachelor
Teacher:	RNDr. Martin Kuřil, Ph.D.
Term:	Winter semester
Language of instruction:	English
Lectures/exercises:	2/2 per semester
Completion:	EXAM
Course goal:	The one-semester undergraduate course in abstract algebra covers the basics of groups and rings and briefly touches on field theory.
Abstract:	1. Groups (the integers mod *n*, symmetries, definitions and examples, subgroups). 2. Cyclic groups. 3. Permutation groups (definitions and notation, the dihedral groups). 4. Cosets and Lagrange's Theorem (cosets, Lagrange's Theorem, Fermat's and Euler's Theorems). 5. Isomorphisms (definition and examples, direct products). 6. Homomorphisms and factor groups (factor groups and normal subgroups, group homomorphisms, the isomorphism theorems). 7. The structure of finite abelian groups. 8. Rings (rings, integral domains and fields, ring homomorphisms and ideals, maximal and prime ideals). 9. Polynomials (polynomial rings, the division algorithm, irreducible polynomials). 10. Fields (fields of fractions, extension fields).