PÁZMÁNY
Pázmány Péter Catholic University
Faculty of Information Technology and Bionics

COURSE CATALOGUE

FOR INTERNATIONAL STUDENTS

ACADEMIC YEAR
2025/2026

PÁZMÁNY PÉTER CATHOLIC UNIVERSITY
Faculty of Information Technology and Bionics

Content

COURSE SELECTION GUIDELINES

This course catalogue is intended for international students coming to the Faculty of Information Technology and Bionics at Pázmány Péter Catholic University (PPKE ITK) either as ***Erasmus+ exchange students*** (for one or two semesters) or as ***guest students*** studying at another Hungarian university.

As an exchange or guest student, you may choose from a wide range of courses, subject to availability. You are free to enrol in as many courses as you wish - from a single course to a full course load -, allowing you to tailor your learning experience to your individual interests and academic goals. *(Please note: additional conditions may apply for Erasmus+ students.)*

This catalogue lists the courses offered by our Faculty in English. At PPKE ITK, ***all master's-level courses are taught in English***. In the autumn semester, ***some bachelor's-level courses are also available in English***. Some courses are offered in Hungarian by default, but upon individual request and at the lecturer's discretion, it may be possible to attend the course in English or complete it through alternative arrangements (e.g. written materials and occasional individual consultations to support self-directed learning). These courses are also included in the catalogue.

Class schedules can be found in the Neptun academic administration system or obtained directly from the international coordinators.

COORDINATORS AND TUITION FEES

ERASMUS+ EXCHANGE STUDENTS

Erasmus+ coordinator: ***Ms Mónika BARNÁNÉ ÓDOR***

International Relations Office ✉ barnane.odor.monika@itk.ppke.hu

For Erasmus+ exchange students, all courses are free.

INTERNATIONAL GUEST STUDENTS

Guest student coordinator*:* ***Ms Rita OLAJKÁR-HARASZTI***

Academic Administrations Office ✉ olajkar-haraszti.rita@itk.ppke.huInternational guest students have to pay the following tuition fees:

- 15,000 HUF / ECTS for students with EU citizenship
- 35,000 HUF / ECTS for students from outside the EU

FURTHER INFORMATION

Detailed further information can be found on the following webpages:

- for *Erasmus+ exchange students*
- for *International guest students*

Advanced Java Programming

Semester	Autumn
Subject code	P-ITSZT-0017
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Kálmán Tornai
End-term evaluation	Practical mark

Course Description

The objective of this subject is to deepen students' knowledge of the Java programming language and related tools. In addition, students are required to implement a complex programming project during the semester to gain hands-on experience. The technologies covered in this subject include Spring Boot, Injection+Bean, JPA, JS frontend, REST, SOAP, and Maven.

Advanced Quantum Mechanics

Semester	Spring
Subject code	P-ITFIZ-0021
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	András Lászlóffy
End-term evaluation	Exam

Course Description

The aim of the course is to provide students with the opportunity to study the fundamental principles of quantum mechanics in greater depth.

Angular

Semester	Autumn
Subject code	P-ITSZT-0059
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Balázs Karlóczai
End-term evaluation	Practical mark

Course Description

The objective of this subject is to deepen students' understanding of the architecture behind an Angular application and how it works. The knowledge gained of Angular fundamentals will enhance students' frontend development skills, enabling them to develop complex, scalable, and responsive web applications. In addition, students are required to implement a complex programming project during the semester to gain practical experience. Technologies covered by the syllabus, in addition to Angular, include HTML, CSS, JavaScript, and TypeScript.

Applications of Machine Learning in Biotech and Medtech

Semester	Autumn
Subject code	P-ITSZT-0061
ECTS credit value	5 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 3
Recommended level of study	MSc
Lecturer	András Horváth
End-term evaluation	Practical mark

Course Description

An introduction to the methodology of machine learning, offering a broad overview of key approaches and techniques.

Applications of Neural Microsystems

Semester	Spring
Subject code	P-ITBIO-0042
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Ágnes Szabó
End-term evaluation	Exam

Course Description

The course provides insight into the interdisciplinary field of neural microsensors and actuators, drawing on recent advances in both materials science and neuroscience. Operating principles and technological challenges will be explored through real-world applications.

Applied Immunology

Semester	Spring
Subject code	P-ITMED-0024
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Éva Pállinger
End-term evaluation	Exam

Course Description

The practical applications of immunology—immune biotechnology, vaccination, flow cytometry, immunopharmacology, immunogenomics, cytofluorimetry, endophenotyping, monoclonal antibodies, therapeutic antibodies, immune constructs, immunoepigenetics, and immune databases.

Applied Systems Biology

Semester	Autumn
Subject code	P-ITBIO-0051
ECTS credit value	4 credits
Number of classes per week	Lecture: 4 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Attila Csikász-Nagy
End-term evaluation	Practical mark

Course Description

The goal of this course is to highlight recent results in systems biology-oriented applications. Local and guest lecturers will present the basic concepts and advanced research topics in key areas of systems biology. Topics include biological networks, network motifs, stochastic simulations, logical modelling, whole-cell models, metabolic networks, circadian rhythms, riboswitches, cancer, and more.

Basic Image Processing Algorithms

Semester	Autumn
Subject code	P-ITJEL-0014
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc

Lecturer	Csaba Benedek
End-term evaluation	Exam

Course Description

The aim of the course is to introduce the basic algorithms used in digital image processing and computer vision. The first part of the semester covers topics from the classical image processing era, such as image representation, 2D convolutions, image enhancement and recovery, texture analysis, and Fourier space-based image filtering. The second part of the course focuses on more recent tools, including Mean Shift and Markov Random Field segmentation models, the extraction and use of SIFT, HOG, and BLP descriptors, and the basics of applying machine learning approaches to image recognition problems.

No prior knowledge of image processing or computer vision is assumed for this course. However, students are expected to have a solid programming background, as well as experience with data structures, linear algebra, vector calculus, and the basics of signal processing.

Basics of Computer Graphics (A számítógépes grafika alapjai)

Semester	Spring
Subject code	P-ITSZT-0047
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	BSc / MSc
Lecturer	Csaba Benedek
End-term evaluation	Exam

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

The main goal of the course is to introduce the basic concepts and tools of computer graphics and provide practical experience through OpenGL exercises within a C++ programming framework. The main topics include: (1) Introduction and foundations of OpenGL, (2) Geometric modeling, (3) Geometric transformations, (4) Animations, (5) Texture modeling and analysis, (6) Color and illumination modeling, (7) 2D image synthesis, and (8) Virtual world models.

Basics of Hungarian Language

Semester	Autumn
Subject code	P-ITPRE-0018/A
ECTS credit value	4 credits
Number of classes per week	Lecture: 0 / Practice: 4 / Lab: 0
Recommended level of study	MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

Absolute beginner course designed to introduce students to basic Hungarian. The vocabulary and grammar are appropriate for level A1.1. Students will learn to read and understand simple sentences, and they will be able to form questions and answers.

By the end of the semester, they will be able to talk about themselves, their family, and their country, as well as express themselves in simple, everyday situations such as shopping, dining in restaurants, and more.

Basics of Mobile Application Development

Semester	Autumn
Subject code	P-ITJEL-0015
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 3
Recommended level of study	MSc
Lecturer	Kálmán Tornai
End-term evaluation	Practical mark

Course Description

The aims of the course are to introduce the development of applications on common mobile platforms and to provide basic knowledge about these platforms. The course is complemented by platform-specific courses planned for the next semester.

Students will gain insight into fundamental issues of software ergonomics, learn appropriate solutions, and become familiar with techniques for handling new peripherals found in current and emerging mobile devices.

Basics of Neurobiology

Semester	Autumn

Subject code	P-ITBIO-0013
ECTS credit value	6 credits
Number of classes per week	Lecture: 3 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Imre Kalló
End-term evaluation	Exam

Course Description

Understanding the structure and function of the nervous system at the molecular, cellular, and macroscopic levels.

Bio- and Drug Delivery MEMS

Semester	Autumn
Subject code	P-ITEEA-0024
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	Kristóf Iván
End-term evaluation	Exam

Course Description

The aim of the course is to teach the basic principles of MEMS design and fabrication and to familiarize students with various biomedical MEMS devices and drug delivery systems. Topics covered include: Introduction to BioMEMS, soft microfabrication, silicon-based microfabrication, MEMS design and fabrication, microfluidics, clinical laboratory medicine, sensor principles and microsensors, microactuators and drug delivery, lab-on-a-chip systems and microTAS, genomics and DNA arrays, proteomics and protein arrays, biosensors, immuno-isolation capsules, stents, microneedle arrays, micropumps and related applications, biocompatibility, surface treatment methods, MEMS packaging, polymer-based drug delivery, and MEMS-based drug delivery.

Bioanalytics and Molecular Diagnostics

Semester	Autumn
Subject code	P-ITMED-0029
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Csaba Pongor
End-term evaluation	Exam

Course Description

The aim of the course is to learn the basic principles of MEMS design and fabrication and to familiarize students with various biomedical MEMS devices and drug delivery systems. Students will get acquainted with the following topics: Introduction to BioMEMS, soft microfabrication, silicon-based microfabrication, MEMS design and fabrication, microfluidics, clinical laboratory medicine, sensor principles and microsensors, microactuators and drug delivery, lab-on-a-chip systems and microTAS, genomics and DNA arrays, proteomics and protein arrays, biosensors, immuno-isolation capsules, stents, microneedle arrays, micropumps and related applications, biocompatibility, surface treatment methods, MEMS packaging, polymer-based drug delivery, and MEMS-based drug delivery.

Bioanalytics Practice

Semester	Autumn
Subject code	P-ITMED-0030
ECTS credit value	4 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 4
Recommended level of study	MSc
Lecturer	Csaba Pongor
End-term evaluation	Exam

Course Description

Analytical methods are essential tools in modern biosciences. The main goal of this course is to provide an in-depth overview of bioanalytics and molecular diagnostics. Additionally, it will give students a solid foundation for subjects such as genomics, proteomics, and metabolomics. While the focus will be on applications, students will also learn the physical and chemical theory behind bioanalytical methods. The course is divided into two parts: (1) Cell biology – a summary and intensification of cell biology knowledge with special emphasis on cell physiology; (2) Cell technology – theoretical knowledge in preclinical (cancer) research, focusing on the use of (cancer) cells as model systems in in vitro and in vivo experiments.

Biomedical Imaging (Orvosi képalkotó módszerek)

Semester	Spring
Subject code	P-ITBIO-0050
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	BSc / MSc
Lecturer	Sándor Földi

End-term evaluation	Exam

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

The course offers an overview of imaging methods used in clinical and research practice. The lectures provide a practical introduction to modern X-ray devices (CT, PET, PET-CT, and MRI) as well as the fundamentals of image creation and analysis. The majority of the course focuses on the details of MR imaging and its applications. Practical sessions emphasize the analysis of functional MR images.

Biomedical Signal Processing

Semester	Autumn
Subject code	P-ITJEL-0024
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Janka Hatvani
End-term evaluation	Practical mark

Course Description

Basic techniques in signal processing relevant to biomedical signals, illustrated through practical applications. Topics covered include biomedical signal genesis; signal representation; signal decomposition; source separation; autoregressive (AR) estimation; Fourier analysis; time-frequency analysis; wavelets; sparse decomposition; data fusion; classification; and non-stationary signals. Signal modalities studied include pulse oximetry, phonocardiography, ECG, and EEG.

Biometrics in Person Identification

Semester	Spring
Subject code	P-ITJEL-0060
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Miklós Koller
End-term evaluation	Exam

Course Description

The course gives an overview of various biometric identification methodologies and existing systems based on computer vision tools. The introduced techniques offer great opportunities in the fields of surveillance systems and intelligent multimedia equipment.

Bionanotechnology and Synthetic Biology

Semester	Spring
Subject code	P-ITFIZ-0015
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Zoltán Gáspári
End-term evaluation	Exam

Course Description

The course aims to provide advanced knowledge in the following subjects:

- design, investigation, and application of self-assembling systems
- methods for cargo transport in biological systems
- principles of molecular delivery through biomembranes
- molecular design for enzyme catalysis
- principles and applications of directed evolution techniques
- applications of molecular recognition in medical diagnostics
- design and application of biocompatible nanomaterials.

Bionics in Practice

Semester	Spring
Subject code	P-ITEEA-0035
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Dániel Györffy
End-term evaluation	Practical mark

Course Description

Introducing bionic research, development, manufacturing, and applications through visits to labs and companies. Students work in teams and give a presentation on a bionics-related topic

(e.g. bionic sensory perception, bionic prostheses, neurostimulators, bioanalytics, etc.), which will be evaluated by other teams based on a given evaluation scheme. After the presentation, the team leads a discussion on related (ethical) questions. The aim of the course is to deepen understanding of the bionics field—its opportunities, results, efforts, challenges, successes, and failures—through peer learning.

Biophotonics

Semester	Autumn
Subject code	P-ITJEL-0059
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Csaba Pongor
End-term evaluation	Exam

Course Description

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Biostatistics

Semester	Autumn
Subject code	P-ITMAT-0040
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	János Juhász
End-term evaluation	Exam

Course Description

The aim of the course is to provide the foundational knowledge required to understand and manage random fluctuations in natural phenomena. It introduces the methodology for evaluating research and measurement results and equips students with the skills needed to comprehend scientific literature.

Brain Therapy Technologies

Semester	Spring
Subject code	P-ITMED-0028

ECTS credit value	3 credits
Number of classes per week	Lecture: 1 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Dániel Hillier
End-term evaluation	Exam

Course Description

Therapy for brain diseases remains one of the greatest challenges of the century. Success will rely on broad interdisciplinarity spanning computer science, engineering, medicine, and molecular biology. This course introduces the field and offers practical experience through small group work.

Business English

Semester	Autumn
Subject code	P-ITANG-0008
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 2 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

The course provides insight into the business world where English is used as the primary means of communication. Through topic-specific units, case studies, interviews, role plays, and more, students gain up-to-date knowledge of how this environment operates and what challenges they may encounter when working in an international setting.

The course book, *Business Result Advanced*, offers high-level language practice that can be challenging even for students with a strong C1-level proficiency.

Cell Technology

Semester	Spring
Subject code	P-ITMED-0027
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Tamás Garay
End-term evaluation	Exam

Course Description

The course is divided into two parts:

1. Cell Biology – a summary and deepening of cell biology knowledge with special emphasis on cell physiology
2. Cell Technology – theoretical knowledge in preclinical (cancer) research: how to use (cancer) cells as model systems in in vitro and in vivo experiments.

Chemical Biology

Semester	Autumn
Subject code	P-ITBIO-0045
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Zoltán Gáspári
End-term evaluation	Exam

Course Description

Chemical aspects of biological processes. Proteins and biopolymers, post-translational modifications. Intrinsically disordered proteins. Chemical aspects of protein synthesis in the laboratory and in the cell. Internal dynamics of proteins and their significance, basic concepts in protein NMR spectroscopy. Chromatin organization and an introduction to epigenetics.

Combinatorial Methods

Semester	Spring
Subject code	P-ITMAT-0033
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Bernadett Ács
End-term evaluation	Exam

Course Description

The course covers the following topics: interval systems; graph coloring and sequential algorithms; classes of perfect graphs; maximum and stable matchings in bipartite graphs; list coloring and the kernel method; large cuts in graphs; greedy algorithms; the probabilistic

method; dynamic programming algorithms; balanced incomplete block designs and finite geometries; extremal problems; forwarding index; factorization and decomposition.

Computer Controlled Systems

Semester	Autumn
Subject code	P-ITJEL-0042
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Gábor Szederkényi
End-term evaluation	Exam

Course Description

The course covers the following topics: Models of continuous-time linear time-invariant (CT-LTI) systems (higher-order linear differential equations, transfer function, impulse response function, state-space model); controllability and observability of CT-LTI systems; joint controllability and observability of CT-LTI systems: minimality, irreducibility, system decomposition; stability of CT-LTI systems (notion of stability in the general nonlinear case, Lyapunov function, Lyapunov theorem, BIBO stability, asymptotic stability of CT-LTI systems, Lyapunov theorem for CT-LTI systems); transfer functions in the frequency domain (gain, phase), Bode and Nyquist diagrams, different interconnections of SISO CT-LTI systems, minimum phase systems; basic control of CT-LTI systems: control goals, system inversion (and its problems), the notion and types of feedback, the role of the integrator in a control loop, PID controllers; pole placement control design; state observer design for CT-LTI systems, the separation principle; Linear Quadratic Regulator (LQR); sampling and discretization of CT-LTI systems, description of discrete-time linear time-invariant (DT-LTI) systems (state-space model, pulse transfer operator); controllability, reachability, and observability of DT-LTI systems; stability of DT-LTI systems: stability of the solutions of DT state equations, asymptotic stability of DT-LTI systems, Lyapunov theorem for DT-LTI systems; DT LQR controller, deadbeat control, DT state estimation; DT stochastic models, Kalman filter.

Computerised Systems Biology 1 (Számítógépes rendszerbiológia I.)

Semester	Spring
Subject code	P-ITBIO-0015
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Attila Csikász-Nagy

END-TERM EVALUATION	EXAM

REMARK

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

COURSE DESCRIPTION

Students will learn computational methods to model biological regulatory networks, gaining skills to select the best approach for various biological questions. Methods will be introduced through real examples, with students creating their own models in group projects.

Semester schedule:

- Basics of biology, math, and systems biology
- Enzyme kinetics and differential equations
- Network models and graph analysis
- Biological network analysis and databases
- ODE models and graphical solutions
- Model simulation, parameter estimation, sensitivity analysis
- Biological oscillators and synthetic models
- Metabolic networks and flux balance analysis
- Spatial models and reaction-diffusion systems
- Evolutionary game theory and cell interaction models

COMPUTERISED SYSTEMS BIOLOGY 2 (SZÁMÍTÓGÉPES RENDSZERBIOLÓGIA II.)

SEMESTER	AUTUMN
SUBJECT CODE	P-ITBIO-0016
ECTS CREDIT VALUE	3 CREDITS
NUMBER OF CLASSES PER WEEK	LECTURE: 1 / PRACTICE: 1 / LAB: 0
RECOMMENDED LEVEL OF STUDY	BSC / MSC
LECTURER	ATTILA CSIKÁSZ-NAGY
END-TERM EVALUATION	EXAM

REMARK

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

COURSE DESCRIPTION

Students will learn computational techniques for modeling biological regulatory networks. They will become familiar with a range of methods and develop the skills to select the most appropriate approach for different biological questions. These modeling methods will be

presented through real biological examples, and students will have the opportunity to create their own models as part of a group project.

Data Analysis in Molecular Diagnostics

Semester	Spring
Subject code	P-ITMED-0012
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Balázs Ligeti
End-term evaluation	Exam

Course Description

Advanced course in Bioinformatics. The aim of the course is to provide deeper, hands-on knowledge in bioinformatics focused on big data, particularly large-scale sequencing data. Topics include DNA sequencing techniques such as metagenomics, exome sequencing, and RNA-seq. The course covers algorithms and statistical methods for extracting novel biological insights, including NGS algorithms like BWT and FM-index. It also introduces modern data representations and frameworks, such as network analysis, Docker containers, working in HPC environments, and SPARK. Students will develop skills to understand and design complex analysis pipelines. Modern machine learning algorithms in biology are covered, including CART, LASSO, T-SNE, PCA, and PERMANOVA. The course also includes training on R and Python data science platforms and data visualization techniques.

Data Analytics in Sports and Rehabilitation

Semester	Autumn
Subject code	P-ITEEA-0050
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	László Grand
End-term evaluation	Exam

Course Description

The course covers data analytics methods commonly used in sports and rehabilitation, ranging from statistical analysis to cutting-edge machine learning and deep learning algorithms. It introduces sensor technologies applied in this field and an overview of gross human muscular anatomy, as well as heart and vascular anatomy and physiology. Students will learn techniques

for synchronized movement and muscle activity recording and analysis during practice. The course also discusses sport-specific data analytics strategies, techniques, and challenges, with a focus on kayaking, football, and tennis. The methods acquired can also be applied in other fields where time-series and complex network dynamics analysis or modeling play significant roles.

Data Compression Methods

Semester	Spring
Subject code	P-ITPRO-0002
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Gergely Feldhoffer
End-term evaluation	Practical mark

Course Description

Compression algorithms and their implementation for general-purpose lossless compressors, as well as lossy multimedia compressors for audio, image, and video.

Data Mining and Machine Learning

Semester	Autumn
Subject code	P-ITSZT-0053
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Gergely Lukács
End-term evaluation	Exam

Course Description

This course covers the fundamental concepts of data mining, including:

- The input and output of the data mining process
- Types of tasks (e.g., clustering, classification, numeric prediction, association rule mining)
- Evaluation methods
- Selected algorithms
- Pre-processing and post-processing techniques
- Ensemble learning methods

Data Security and Criptography (Adatbiztonság és kriptográfia)

Semester	Spring
Subject code	P-ITSZT-0058
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 1
Recommended level of study	BSc / MSc
Lecturer	Márton Csapodi
End-term evaluation	Exam

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

Cryptography, especially public key cryptography, has become a crucial discipline over the past 40 years. Its importance is demonstrated not only by extensive theoretical research but also by the widespread use of secure IT systems and security applications. Cryptographic protection is a fundamental requirement in many areas of communication, leading to the development of numerous standards in recent years. Today, public key cryptography is commonplace in financial services and government applications, and it is widely used in business and private contexts (e.g., SSL/TLS, S/MIME).

This course introduces students to the most important techniques and applications of cryptography. It provides a general overview of the following areas: mathematical foundations; random number generators; symmetric key encryption (stream and block ciphers, TDEA, AES, secure mobile communication); public key encryption (basics, RSA encryption, Diffie-Hellman, elliptic curves); hash functions; authentication (passwords, challenge-response protocols); public key infrastructure; and electronic signatures. Laboratory sessions enable students to examine security mechanisms in operating systems and network protocols, as well as to develop cryptographic programming skills.

Data Visualization in Bioinformatics and Systems Biology

Semester	Spring
Subject code	P-ITJEL-0057
ECTS credit value	2 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Sándor Pongor
End-term evaluation	Practical mark

Course Description

Presenting measured data and complex results has emerged as a distinct challenge in the life sciences. How can we design effective visual representations from numerical or textual data? How can we condense millions of data points into a single, comprehensible pattern or trend? This course focuses on visualizing biological sequences, genomes, clinical data, metagenomes, gene expression data, molecular 3D structures, and (brain) networks, while also touching on small molecules such as pharmacons. The goal is to equip students with the knowledge to choose appropriate visualization tools and to understand their respective strengths and limitations.

Database systems II

Semester	Autumn
Subject code	P-ITSZT-0057
ECTS credit value	2 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Gergely Lukács
End-term evaluation	Exam

Course Description

The course covers the following topics: cost-based query optimization; object-relational databases; application development with database management systems, including object-relational mapping; data warehousing, ETL processes, and business intelligence (BI) tools.

Design Patterns

Semester	Autumn
Subject code	P-ITSZT-0040
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	István Reguly
End-term evaluation	Exam

Course Description

Students will learn about basic programming design patterns, through examples that demonstrate common problems and solutions that offer agility, reliability and extensibility.

Diagnostic Ultrasound Imaging

Semester	Autumn
Subject code	P-ITJEL-0025
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Miklós Gyöngy
End-term evaluation	Practical mark

Course Description

This course provides an understanding of the physical principles behind diagnostic ultrasound imaging, including how conventional (B-mode) and other ultrasound modalities are formed, what the images represent, and how image quality can be enhanced using various techniques. In addition to presenting the current understanding of ultrasound image formation, the course also highlights areas of active research in the field.

Digital IC Design

Semester	Spring
Subject code	P-MIM_D35
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Péter Földesy
End-term evaluation	Practical mark

Course Description

The aim of the course is to provide an overview of the digital ASIC (Application-Specific Integrated Circuit) design flow, highlighting its similarities and differences compared to FPGA-based development. The lectures introduce the design process in detail, supported by real-world examples. In addition to covering CAD tools and design methodologies, the course also presents architectural solutions used in building complex integrated circuits—such as random logic, memory, multipliers, flash, and basic or advanced IP blocks for I/O and core operations.

Drug Delivery Systems

Semester	Spring
Subject code	P-ITMED-0019
ECTS credit value	4 credits

Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	István Antal
End-term evaluation	Exam

Course Description

This course is recommended for students interested in pharmaceutical development, particularly in the formulation of dosage forms and medicinal preparations. Drug Delivery Systems are defined as carrier systems designed for specific routes of administration, aiming to optimize pharmacokinetics, enhance effectiveness, and improve tolerability with fewer side effects. The course focuses on the relationship between pharmaceutical dosage forms and the fate of the drug in the body, including the time course and intensity of drug action, as well as the physicochemical properties of both the drug and the dosage form.

Drug Research and Development (Gyógyszerkutatás és fejlesztés)

Semester	Spring
Subject code	P-ITBIO-0011
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	BSc / MSc
Lecturer	Franciska Vidáné Erdő
End-term evaluation	Exam

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

This course presents the entire system of drug research and development—from in silico drug design and high-throughput screening to genomic and proteomic approaches, as well as traditional in vivo animal experiments. It provides an overview of the methodological toolbox of pharmacology, pharmacokinetics, and toxicology, along with experimental design, data evaluation, and relevant quality assurance regulations. The course covers discovery research, preclinical development, and all phases of clinical drug research and development. In the final lecture, the applications of 3D printing in drug research and biomedicine will be discussed.

In addition to lectures, students will participate in lab visits and practical sessions. They will have the opportunity to visit the high-throughput screening laboratory at Richter Gedeon Pharmaceuticals, the in vitro laboratory of Solvo Biotechnology in Lágymányos, and the bioanalytical laboratory of AURICOOP in Újpest. The course also includes four practical sessions

(each lasting three hours) during which students will be introduced to selected tools from the pre-clinical pharmacology toolbox through simple hands-on examples.

Electrical Measurements Laboratory

Semester	Autumn
Subject code	P-ITEEA-0057
ECTS credit value	2 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	György Cserey
End-term evaluation	Exam

Course Description

The course covers the following topics: modeling, error calculation, measurement uncertainty; voltage and current measurement; frequency and time measurement; sampling and quantization; signal resolution and decomposition into components; biological signals and measurements; and medical measurement techniques.

Measurement exercises include: LabVIEW-based measurements using the ELVIS system, diode measurement, and transistor measurement.

Electromagnetic Metamaterials and Applications

Semester	Autumn
Subject code	P-ITFIZ-0010
ECTS credit value	4 credits
Number of classes per week	Lecture: 4 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Zsolt Szabó
End-term evaluation	Exam

Course Description

The goal of this course is to introduce engineering students to the interaction of electromagnetic waves with artificial electromagnetic structures, such as composites, metamaterials, and photonic crystals. Following an explanation of the physical foundations, the course covers commonly used electromagnetic structures and presents various devices that utilize these artificial materials across scales ranging from millimeters to nanometers.

Electronic Devices and Circuits

Semester	Spring
Subject code	P-ITFIZ-0022
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Ádám Papp
End-term evaluation	Exam

Course Description

Fundamentals of classical circuit theory, complemented by laboratory exercises that demonstrate the core principles in practice. One of the objectives is to help students understand the behavior of classical electrical components that are essential parts of any practical quantum hardware.

Embedded Electronic Systems

Semester	Spring
Subject code	P-ITEEA-0045
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Ákos Zarándy
End-term evaluation	Exam

Course Description

In recent years, embedded systems have proliferated and become increasingly important as their applications have expanded. They are essential for communication, environmental monitoring, and enabling smart devices. Technologies such as the Internet of Things (IoT), Cyber-Physical Systems, and Industry 4.0 are all built upon embedded electronic systems.

The objective of this course is to provide a comprehensive understanding of the design concepts, architecture, and fundamental components of embedded electronic systems. It covers the main electronic components of communicating and sensing embedded devices, along with their core design principles. Critical aspects of implementation are introduced through practical examples from software, hardware, and system perspectives.

Upon successful completion, students will understand the key engineering challenges of modern embedded devices and be able to apply these devices to solve practical problems. Additionally, the course offers motivated students the opportunity to participate in international research projects in this field.

English for Academic Purposes

Semester	Autumn
Subject code	P-ITANG-0009
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 3 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

Pursuing either BSc or MSc studies at Pázmány ITK requires an overall IELTS score of at least 6.5. Students who have been admitted but have not yet demonstrated proficiency at this level are required to take this course. The course prepares students to achieve an IELTS Academic score of 6.5 or higher.

Since all IELTS skills—reading, writing, speaking, and listening—are essential for academic success, the course emphasizes a balanced approach to each. Through mock exams, role plays, and test exercises conducted in a true academic environment, students will develop the skills necessary to pass the internal exam with the required score.

English for Academic Purposes II

Semester	Spring
Subject code	P-ITANG-0011
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 3 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

English for Academic Purposes II is an intensive course focused on the principles of excellent academic writing for scientists. It prepares students to produce a variety of texts, including research papers, conference proposals, posters, book chapters, technical reports, dissertations, and effective presentations.

Class discussions emphasize the central role of rhetorical positioning in crafting clear, engaging, and rigorous scientific research papers. Topics include narrowing the problem space, constructing logical arguments, reporting and interpreting data, and other key concepts such as reader-oriented writing, genre conventions, precision, tone, and strategies for redrafting and editing.

Students will analyze and practice writing sub-genres such as introductions, data commentaries, results and discussion sections, conclusions, and abstracts.

English for Erasmus Purposes

Semester	Spring
Subject code	P-ITANG-0006
ECTS credit value	0 credits
Number of classes per week	Lecture: 0 / Practice: 2 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

This course is designed to assist students planning to study at an English-speaking higher education institution through the Erasmus program. It prepares students for the academic environment they will encounter, as well as the tasks and assignments required by their host university. The curriculum offers opportunities to practice reading comprehension, academic writing, presentations, and conversational skills in an academic context.

FPGA-based Algorithm Design

Semester	Autumn
Subject code	P-ITEEA-0014
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Zoltán Nagy
End-term evaluation	Exam

Course Description

The aim of the course is an introduction to the design of digital circuits using the VHDL language to implement complex applications. Students will gain experience in modeling digital circuits using VHDL. Main topics covered: Register Transfer Level (RTL) description, simulation, circuit implementation on FPGA, testing, and optimization of the designed circuits.

Functional Analysis

Semester	Spring

Subject code	P-ITMAT-0025
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Zsuzsanna Gerencsérné Vágó
End-term evaluation	Exam

Course Description

Metric spaces, normed spaces, inner product spaces. Basics: sequence and function spaces. The topology of metric spaces. Open, closed, and compact sets. Completeness. Measure and integration. Riemann and Lebesgue integrals. Lebesgue Lp spaces. Fourier analysis in Hilbert space. An introduction to abstract linear operator theory.

Fundamentals and Basic Tools for Deep Learning

Semester	Autumn
Subject code	P-ITJEL-0062
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	András Horváth
End-term evaluation	Exam

Course Description

The objective of this subject is to address machine learning problems from a Bayesian perspective. Graphical models (GMs) will be introduced as probabilistic models in which dependence and independence relations between random variables are described in terms of a graph. Similarly, Bayesian networks are a particular case of GMs that are especially useful for modeling conditional independences. Exact inference algorithms will be addressed (such as variable elimination, sum-product, and junction tree) and how they can be applied efficiently. These will be studied in this course alongside the relation between inference and learning. More general approximate inference methods, either deterministic (e.g., variational inference or expectation propagation) or based on sampling and simulation (e.g., Monte Carlo methods based on Markov chains), will also be introduced in this course.

Fundamentals of Quantum Mechanics

Semester	Autumn
Subject code	P-ITFIZ-0020
ECTS credit value	5 credits

Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Exam

Course Description

The course covers the fundamental principles of quantum mechanics, with a focus on wave mechanics. It also presents applications of quantum mechanics in chemistry and semiconductor physics.

Guided Individual Study (GIS)

Semester	Autumn / Spring
Subject code	P-ITFIZ-0020
ECTS credit value	1-4 credits
Number of classes per week	NA.
Recommended level of study	BSc / MSc
Lecturer	NA.
End-term evaluation	Exam

Course Description

This course provides an opportunity for students to engage in independent academic or development work under the supervision of one or more advisors. The chosen topic is not linked to any specific course in the standard curriculum but is defined individually through an agreement between the student and the supervisor.

To participate, students must submit a formal request around the middle of the semester, specifying the proposed topic. The request must be approved and signed by the supervisor. Final approval is granted by the Head of Program.

At the end of the semester, students present their work in an oral report. Based on this presentation and the supervisor's recommendation, the final grade (on a scale of 1–5) and the number of credits awarded (between 1 and 4 ECTS) are determined. The final decision is officially recorded during the oral report session, after which the course is entered into the Neptun system.

High-level Synthesis Methods on FPGA-s

Semester	Autumn
Subject code	P-ITEEA-0016
ECTS credit value	5 credits

Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Zoltán Nagy
End-term evaluation	Exam

Course Description

Digital circuits are traditionally designed using specialized hardware description languages like VHDL and Verilog at the Register Transfer Level (RTL). The increasing complexity of today's digital systems requires more efficient and accessible design methodologies. High-Level Synthesis (HLS) methods have been an active research area since the 1980s and have finally matured for use in industrial applications. Unlike traditional VHDL-based design flows, the input of an HLS synthesis system is a standard ANSI C/C++ description, and the structure of the synthesized architecture can be defined using compiler directives. Changing the directives requires less design effort and much less time to generate several different architectures for the same algorithm. The different solutions' area, speed, power dissipation, and memory bandwidth parameters can be compared during design space exploration, and the best one can be selected for a particular implementation.

Human Physiology I

Semester	Spring
Subject code	P-ITMED-0002
ECTS credit value	4 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Enyedi
End-term evaluation	Exam

Course Description

Cell biology background of physiological functions of the human body (electrophysiological background of the function/activity of excitable tissues); differences and similarities of different muscle types; organization and function of the cardiovascular system; the respiratory system, ventilation, and gas exchange; regulation of circulation and respiration based on the knowledge of the autonomic nervous system; understanding the composition of body fluids with a focus on blood (significance of soluble and cellular components, including defense reactions and hemostasis).

Human Physiology II

Semester	Autumn

Subject code	P-ITMED-0003
ECTS credit value	4 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Enyedi
End-term evaluation	Exam

Course Description

The function of the kidneys, urine formation, regulation of body fluid volume and osmotic parameters. Acid-base balance. Function of the gastrointestinal tract, energy metabolism, regulation of body temperature. Endocrine regulation of physiological processes, the hypothalamo-hypophyseal unit; the adrenal and thyroid glands; calcium metabolism together with bone physiology. Organization of the nervous system, regulation of motor function. The somatosensory system. Sensory organs: vision, hearing, taste, and smell.

Hungarian and European Civilization and Culture

Semester	Spring
Subject code	P-ITMUV-0019
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 3 / Lab: 0
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

The course will provide information on the basic values and trends of European civilization and culture to students mainly from a non-European background at Pázmány Catholic University. The topics cover the main cultural and historical events of the two European millennia that formed the continent as it is now. The course also intends to offer an insight into the history of Hungary from a Catholic perspective. Students are also required to prepare a 10–15-minute presentation on a previously chosen topic from European or Hungarian history or culture to demonstrate their ability to research and understand the given topic in a broader context.

Hungarian Language Course

Semester	Spring
Subject code	P-ITANG-0010
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 3 / Lab: 0

Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

This course is designed for post-beginner learners of Hungarian and serves as a continuation of the autumn course *Basics of Hungarian Language*. It focuses on developing fundamental reading, writing, and speaking skills at the post-beginner level. By the end of the course, students will be able to engage in basic conversations across a range of everyday situations, both formal and informal.

In addition to regular classroom sessions, the course includes a scheduled field trip within Budapest. This excursion offers a valuable opportunity to practice Hungarian in real-life settings and interact with native speakers in a variety of everyday contexts.

Infocommunication Systems

Semester	Autumn
Subject code	P-ITTAV-0004
ECTS credit value	3 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Csurgay
End-term evaluation	Exam

Course Description

The course covers the following topics: Introduction to info-communication systems; Wireline transmission systems (twisted pair, coaxial, fiber); Radio transmission systems (terrestrial, cellular, satellite); Coding, multiplexing, and switching systems; Network structures, PSTN networks, core networks; Mobile networks; Broadcasting systems; Private networks, indoor networks, infocom services; IPTV, ADSL, terminals, regulation of infocom services; ADSL systems, radio-based data communication systems; Summary, next generations of info-communication services.

Information Systems for Investment Banking

Semester	Autumn
Subject code	P-ITSZT-0062
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 0
Recommended level of study	MSc

Lecturer	Norbert Fogarasi
End-term evaluation	Practical mark

Course Description

This course introduces the basic concepts of investment banking and the information systems that support their operation. Many practical applications will be presented by guest speakers from various areas of information technology at one of the largest financial services companies in the world.

Students will be encouraged to ask questions and engage in open discussions about specific case studies from the financial sector. The following list of topics will be covered in the lectures by the guest speakers:

- Introduction to Investment Banking
- Introduction to IT Infrastructure
- IT Development Methodologies at Investment Banks
- Introduction to Finance
- Introduction to Financial Derivatives
- Introduction to Fixed Income Instruments and Pricing
- Bonds and Bond Math
- Credit Derivatives and Supporting Systems
- Equities and Supporting Systems
- Straight Through Processing and Back Office Technology
- Wealth Management Technology
- IT Security at Investment Banks
- Artificial Intelligence and Machine Learning at Investment Banks
- Basic Risk Management Concepts at Investment Banks

Integrated Structural Bioinformatics

Semester	Spring
Subject code	P-ITBIO-0028
ECTS credit value	4 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Zoltán Gáspári
End-term evaluation	Exam

Course Description

Structural representations of macromolecular structures, the Protein Data Bank and the PDB file format. Quality assessment of experimentally solved macromolecular structures. Assignment of secondary structural elements in 3D structures. Detection of domains. Algorithms for 3D structure comparison and alignment, structural classification databases. Predicting protein function from structure, identifying functionally important residues and contacts.

Introduction to protein structure prediction methods, from '1D' to full 3D predictions. Basics of protein–ligand docking. Inclusion of internal dynamics in structural representations. Principles of protein design.

Integration of Information Systems

Semester	Autumn
Subject code	P-MIM_D26
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Márton Csapodi
End-term evaluation	Exam

Course Description

The course deals with the standards and methodology of integration, middleware, and intelligent CASE tools supporting different levels of integration.

Introduction to Artificial Intelligence

Semester	Autumn
Subject code	P-ITSZT-0022
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Kristóf Karacs
End-term evaluation	Exam

Course Description

Introduction: (Embedded) intelligent system and its environment. Intelligent agents. Formalization of problem solving. Informed and uninformed search. Knowledge, representation, conclusion – universal issues. Logical knowledge representation. Propositional calculus. Predicate calculus. Situation calculus. Building knowledge representations. Representation of uncertain knowledge. Modelling uncertainty with fuzzy logic. Planning. Learning agent. Learning. Conclusion.

Introduction to Bioinformatics

Semester	Autumn

Subject code	P-ITBIO-0009
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Sándor Pongor
End-term evaluation	Exam

Course Description

The course is a theoretical and practical introduction to bioinformatics. During the course, we cover the theoretical basics and some important applications of computer use in biology, concentrating on the analysis of DNA and protein sequences. We discuss the basic concepts of bioinformatics (e.g., similarity, proximity measures, data aggregation and projection), alignment techniques (local, global, pairwise, multiple), similarity searching (BLAST), and evolution (phylogenetics). We learn to use some important databases of bioinformatics (e.g., NCBI services). Finally, we become familiar with the core concepts and some typical computational tasks (e.g., assembly, annotation, variant calling) and workflows related to NGS and functional genomics.

Introduction to Functional Neurobiology

Semester	Spring
Subject code	P-ITBIO-0037
ECTS credit value	6 credits
Number of classes per week	Lecture: 3 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Imre Kalló
End-term evaluation	Exam

Course Description

The main objective of the course is to understand the structural and functional concepts characterizing neuronal networks. The course covers the following topics: Membrane characteristics of neurons. The action potential. Synaptic transmission. Synaptic plasticity. Techniques applied in electrophysiology. Motor control by the spinal cord: reflexes and locomotion. Descending supraspinal motor control. Voluntary and involuntary movements. Role of the cerebellum in motor coordination. Brain-machine interfaces. Receptors in the olfactory epithelium. Neuronal networks and function of the olfactory bulb. Structure of the retina. Visual information processing in the retina, thalamus, and visual cortex (demonstration of electrophysiological recordings from the visual cortex). The receptive field. Detection of movement, colour, and contour. Function of the auditory cortex (demonstration of electrophysiological recordings from the auditory cortex). Thalamocortical neuronal networks. Information processing in the thalamus. EEG. Neuronal connections of the hippocampus. Neuronal communication in the hippocampus. Role of the principal neurons and the inhibitory

interneurons. Feedback and feedforward inhibition. Theta activity: mechanism and function. The binding problem: role of gamma oscillation. Molecular mechanism of memory. Learning at cellular and network levels. Behavioural aspects of learning and memory. Computational modelling of neuronal networks. Localization of cognitive processes in the brain. Functional brain mapping. Functional imaging methods (video demonstration of functional imaging techniques; PET, fMRI). Symptoms of neurological diseases. Pathomechanism of epilepsy. Anxiety and depression. Neurosurgery. The hypothalamo-hypophyseo-peripheral gland system. The magno- and parvocellular systems. Regulation of adaptation and metabolism. Neurobiology of reproduction.

Introduction to Hungarian Heritage

Semester	Autumn
Subject code	P-ITPRE-0020
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 3
Recommended level of study	BSc / MSc
Lecturer	Márton Péri
End-term evaluation	Practical mark

Course Description

na.

Introduction to Lab-on-a-chip Devices

Semester	Autumn
Subject code	P-ITLAB-0045
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	András Laki
End-term evaluation	Exam

Course Description

The course covers the following topics: Introduction to lab-on-a-chip devices; Hard fabrication I, II, III; Soft fabrication; Microfluidic principles I, II, III; Practice.

Introduction to Startup Innovation

Semester	Autumn
Subject code	P-ITKOZ-0010
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	András Oláh
End-term evaluation	Exam

Course Description

The direct purpose of the course is to create the foundations of an innovation ecosystem that supports the market translation of research in areas related to the topics of our faculty. This will enable the students and researchers of the faculty to work in an inspirational environment, allowing them to deploy their creative ideas successfully in a sustainable and motivating way. This is achieved by acquiring the most relevant business and soft skills necessary to succeed in the technology-driven, competitive world of startups today.

Java Programming (Java programozás)

Semester	Spring
Subject code	P-ITSZT-0045
ECTS credit value	4 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 3
Recommended level of study	BSc / MSc
Lecturer	Kálmán Tornai
End-term evaluation	Practical mark

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

The objective of the course is to learn the foundations of the Java programming language. The course covers the following topics: Java language syntax, exception handling, I/O, string handling, OOP, interface, Reflection API, Java utilities, generics, threading, graphical user interface, and Java networking.

Journal Club I

Semester	Autumn
Subject code	P-ITKOZ-0014A
ECTS credit value	5 credits
Number of classes per week	Lecture: 1 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Practical mark

Course Description

na.

Journal Club II

Semester	Spring
Subject code	P-ITKOZ-0014B
ECTS credit value	5 credits
Number of classes per week	Lecture: 1 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Practical mark

Course Description

na.

Laboratory Automation I

Semester	Autumn
Subject code	P-ITMED-0031
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Csaba Pongor
End-term evaluation	Exam

Course Description

na.

Machine Learning

Semester	Spring
Subject code	P-ITSZT-0041
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Kristóf Karacs
End-term evaluation	Exam

Course Description

Data preprocessing, attribute selection, supervised learning, regression analysis, classification, linear models, distance metrics, prototype-based methods, Naive Bayes, kernel methods, evaluation, performance measures, unsupervised learning, clustering, dimensionality reduction, latent variable models, graphical models, reinforcement learning, expectation-maximization, ensemble techniques, static, dynamic, stochastic methods (MoE, RBM), end-to-end learning, deep belief networks.

Machine Learning Applications in Biotech and Medtech

Semester	Autumn
Subject code	P-ITSZT-0064
ECTS credit value	5 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 3
Recommended level of study	MSc
Lecturer	András Horváth
End-term evaluation	Exam

Course Description

na.

Machine Learning for Neural Data Analysis

Semester	Autumn
Subject code	P-ITSZT-0060
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Balázs Ujfalussy
End-term evaluation	Exam

Course Description

Machine learning and computer science have a lot to learn from the brain when it comes to efficiency, robustness, generalisation, and adaptivity, yet the code and the algorithms running on the neural hardware are poorly understood. Using state-of-the-art electrophysiological and optical techniques, we are now able to monitor the activity of large numbers of neurons in behaving animals, providing us with an unprecedented opportunity to observe how interacting neural populations give rise to computation.

The aim of the course is to introduce students to recent approaches for analysing and interpreting neuronal population activity data. We will focus on generative models and take a Bayesian perspective: we will learn how to build probabilistic models of the data and how to perform inference and learning using these models. The course is a mixture of lectures focusing on the theoretical background, discussions of neuroscience experiments, and practical sessions where students will apply the learned techniques to real neuronal data. Interaction among students is highly encouraged.

Further information:

https://koki.hun-ren.hu/researchgroups/biological-computation/dissemination-education/courses/ml4nda

Macromolecular Modelling

Semester	Autumn
Subject code	P-ITMED-0033
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Tamás Hegedüs
End-term evaluation	Exam

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

na.

Mathematical Foundations of Quantum Theory

Semester	Spring
Subject code	P-ITMAT-0045

ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Barna Pongrácz
End-term evaluation	Exam

Course Description

The aim of the course is to introduce the mathematical toolkit of quantum mechanics and quantum information theory, laying the foundation for the mathematical skills required in subsequent courses on quantum mechanics.

Methods and Languages of Programming (Programozási nyelvek és módszerek)

Semester	Spring
Subject code	P-ITSZT-0046
ECTS credit value	3 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Kálmán Tornai
End-term evaluation	Exam

Remark

Subject to the explicit approval of the lecturer, and based on prior agreement, the course may be offered in English or completed through alternative study methods (e.g. individual study with occasional consultation). Otherwise, it is held in Hungarian by default.

Course Description

This course provides an introduction to fundamental programming methodologies and the core concepts shared by high-level programming languages. Students will gain a solid foundation in algorithmic thinking, structured programming, and essential language constructs such as data types, control structures, functions, and basic data structures.

Methods in Laboratory Diagnostics

Semester	Spring
Subject code	P-ITMED-0021
ECTS credit value	2 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 0
Recommended level of study	MSc

Lecturer	Barna Vásárhelyi
End-term evaluation	Exam

Course Description

Laboratory results form the basis of up to 70% of clinical decision-making. The ordering and evaluation of laboratory results have a strong impact on the standard of clinical care. Basic knowledge regarding the most common factors influencing the precision and accuracy of laboratory results is essential both for clinicians and for patients. The aim of the course is to provide general information on these issues and to give basic milestones to be adhered to when the students are planning studies applying laboratory methods.

Microbiology in Healthcare and Food Industry

Semester	Autumn
Subject code	P-ITBIO-0047
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Dóra Szabó
End-term evaluation	Exam

Course Description

During the course, students will receive information about general microbiology, with a special focus on microbes responsible for human diseases.

Medical microbiology includes microbiological diagnosis (identification of bacteria, viruses, fungi, and parasites causing diseases), causative treatment (application of active drugs, drug resistance and its detection, and drug discovery), as well as methods of prevention and immunization.

In the context of food-borne microbiology, food-mediated bacterial, viral, and parasitic infections and their detection will also be discussed.

The human normal microflora and its role will also be covered in the course.

Modelling Neurons and Networks

Semester	Autumn
Subject code	P-ITBIO-0040
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc

Lecturer	Imre Kalló
End-term evaluation	Exam

Course Description

Mathematical models and computer simulations have become indispensable tools in neurobiological research, providing quantitative links between data collected using disparate experimental techniques, and even between different levels of description. The course introduces the basic methods employed in the biophysically realistic modeling of single neurons and networks, provides hands-on experience with some of the most commonly used software tools, and demonstrates, through examples, several fundamental principles of neural information processing.

Molecular Biology

Semester	Spring
Subject code	P-ITBIO-0046
ECTS credit value	5 credits
Number of classes per week	Lecture: 4 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Miklós Csala
End-term evaluation	Exam

Course Description

The storage, maintenance, and expression of genetic information, as well as their molecular mechanisms, are fundamental topics of the course. DNA replication, DNA damage and repair, RNA synthesis and processing, protein synthesis, maturation and targeting, and different ways of regulating gene expression are discussed. Regulation of the cell cycle and apoptosis, in light of the molecular background of tumor development, is also part of the subject. Some of the lectures provide insights into molecular biology research.

Further information: https://semmelweis.hu/molekularis-biologia/en/students/med-biotech-msc/

Molecular Genetics, Genomics, Systems Biology

Semester	Spring
Subject code	P-ITMED-0015
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Viola Tamási

End-term evaluation	Exam

Course Description

During the semester, students will learn the basics of genetics and genomics. They will gain knowledge about how the genome is organized, what annotation means, what the Human Genome Project (HGP) was, and what we know about chromosomes, mutations, epigenetic regulation mechanisms, and the role of the genome in medicine. They will also learn parallel techniques related to each topic, covering both genetic and genomic levels of analysis.

Molecular Machines, Bionanotechnology and Synthetic Biology

Semester	Spring
Subject code	P-ITBIO-0057
ECTS credit value	5 credits
Number of classes per week	Lecture: 4 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Zoltán Gáspári
End-term evaluation	Exam

Course Description

na.

Molecular Pathology

Semester	Autumn
Subject code	P-ITMED-0007
ECTS credit value	3 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	József Timár
End-term evaluation	Exam

Course Description

The course covers the following topics:

1. Cell society – stem cells – major regulatory tasks: proliferation and death to maintain specific activities – metabolism for energy

2. Main methods: immunohistochemistry, PCR-based techniques, NGS, liquid biopsy, meta-analysis
3. Signaling pathways (ligands, receptors) – feedback – mutation
4. Epigenetics – splicing – non-coding RNA
5. Carcinogenesis – oncogenes – clonal selection
6. Local invasion – the road to distant metastasis (epithelial-mesenchymal transition) – fenexpression
7. Gene expression (primary vs. secondary) – dormant cells
8. (Onco)hematology
9. Intra- and intertumoral heterogeneity – organ-specific cancers
10. Targeted therapy (concept and reality) – driver genes
11. Resistance – synthetic lethality – DNA repair
12. Non-cancer conditions
13. Ethics in publications – how to digest information
14. Consultation

Molecular laboratories to visit: SE II Institute of Pathology, Oncompass

Molecular Targets in Tumor Therapy

Semester	Spring
Subject code	P-ITMED-0016
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Gergely Keszler
End-term evaluation	Exam

Course Description

Currently, malignancies are the second most frequent cause of death in Hungary. Several genetic, environmental, and lifestyle factors predispose individuals to the development of tumors. The lectures provide up-to-date insights into the (epi)genetics, molecular biology, and metabolism of neoplasias. We review potential molecular targets (enzymes, transporters, and nucleic acids) and the molecular mechanisms of action of conventional and targeted anti-tumor chemotherapeutic drugs. The principal goal of the course is to familiarize students with a molecular way of thinking that may be useful in understanding the molecular basis of targeted chemotherapy in particular and the pathogenesis of human diseases in general.

Multimodal Sensor Fusion and Navigation

Semester	Autumn
Subject code	P-ITEEA-0038

ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	András Horváth
End-term evaluation	Exam

Course Description

The main goal of the course is to give an overview about real time algorithms and architectures used in multi-sensor data fusion and navigation.The focus of the course is multiparallel processing and target tracking.The course introduces estimation theory, the necessary definitions in static, dynamics linear and non-linear cases and also in discrete and continuous systems. Reveals and explained such generally used algorithms like the Kalman- and the Bootstrap-filter. Also the limitations and applications of these algorithms in practical problems. The course gives comprehensive knowledge about system level computations in both top-down and bottom up design of adaptive algorithmic solutions. Examines the topographic and non-topographic partitioning of data-flows regarding the modern multi-parallel architectures.

Multi-photon Microscopy

Semester	Spring
Subject code	P-ITJEL-0044
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Balázs Rózsa
End-term evaluation	Exam

Course Description

The course focuses on the use of a two-photon laser scanning microscope in research. This is a multidisciplinary subject in which students learn the theoretical basics of multiphoton microscopy and acquire some engineering knowledge. Moreover, they are required to improve their rhetorical skills by presenting scientific articles and to participate in lab work in the Two-Photon Laboratory. During the semester, students will learn how a microscope is built and how to use it in a neurobiological project.

Nanoelectronics and Nanotechnology

Semester	Spring
Subject code	P-ITFIZ-0016

ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Ádám Papp
End-term evaluation	Exam

Course Description

The aim of the course is to provide an overview of nanotechnology and nanoelectronics. It also presents the main tools and methods used in microelectronic manufacturing.

Neural Engineering Applications

Semester	Spring
Subject code	P-ITBIO-0054
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	István Ulbert
End-term evaluation	Exam

Course Description

na.

Neural Interfaces and Prostheses

Semester	Autumn
Subject code	P-ITBIO-0038
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	István Ulbert
End-term evaluation	Exam

Course Description

In this course, students will become familiar with recent developments in neural engineering, specifically in the field of neuroprosthetic devices designed to restore lost neural functions. These devices require direct interfaces with the peripheral and central nervous systems. Some of them, such as cochlear prostheses for restoring hearing, are already routinely used in clinical practice, while others are still in the developmental or experimental phase.

Neural Networks

Semester	Autumn
Subject code	P-ITEEA-0011
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Ákos Zarándy
End-term evaluation	Exam

Course Description

During this course, students will learn the theory of deep convolutional neural networks and how to design, implement, and train these networks in practice. They will study modern feedforward networks for classification, detection, and segmentation, as well as recurrent networks and dimensionality reduction techniques.

Neuromorph Movement Control

Semester	Spring
Subject code	P-ITEEA-0043
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	József Laczkó
End-term evaluation	Exam

Course Description

Solving direct (forward) and inverse kinematic problems of multi-joint systems. Optimization in neural control of movements – minimal jerk, minimal energy, and minimal torque change models. Geometric, material, and neuro-mechanical muscle characteristics. Electromyography. Redundancy of the motor system. Variances in movement execution, controlled and uncontrolled manifolds. Muscle and joint synergies. Sensory-motor transformations, high-dimensional biological coordinate systems. Dimension reduction methods, non-negative matrix factorization, principal component analysis, and their application in the control of human-machine interfaces. Body-machine interface. Motor impairments and medical rehabilitation. Application of functional electrical neuro-muscular stimulation.

Neurophysiological Data Analysis

Semester	Spring

Subject code	P-ITBIO-0044
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	István Ulbert
End-term evaluation	Exam

Course Description

The course covers the most significant mathematical data analysis methods useful for understanding neurophysiological processes and extracting more information from measurements. We will start with traditional methods and progress to the most advanced contemporary techniques, while also discussing open questions in the field. Although the primary focus will be on the analysis of electrophysiological signals, the techniques learned will, in principle, be applicable to all branches of science—and beyond—where the aim is to reveal the structure and function of complex systems.

Neuroscience Techniques (in practice)

Semester	Autumn
Subject code	P-ITBIO-0053
ECTS credit value	4 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 3
Recommended level of study	MSc
Lecturer	István Ulbert
End-term evaluation	Exam

Course Description

A practice-oriented introduction to the numerical methods of quantum mechanics.

Nonlinear Dynamical Systems

Semester	Autumn
Subject code	P-ITEEA-0037
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Polcz
End-term evaluation	Exam

Course Description

Content of the course: Basic concepts of the theory of continuous-time and discrete-time dynamical systems (induced by ordinary differential equations and continuous mappings, respectively): well-posedness of problems in differential equations, linearization near hyperbolic equilibria, stability and attraction for compact invariant sets, structural stability and bifurcations, chaos and fractals with indicators and applications, synchronization between two chaotic Chua circuits, and elements of time-series analysis.

Objective of the course: To present dynamical systems as a fundamental model for describing spatiotemporal processes, their numerical methods, and related computer exercises. In addition to basic concepts of nonlinear dynamics, emphasis is placed on error estimates between exact and approximate solutions, on the preservation of qualitative properties of the dynamics by numerical approximations, and on developing a critical attitude toward results provided by computer simulations.

Numerical Analysis I

Semester	Autumn
Subject code	P-ITMAT-0036
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Mihály Kovács
End-term evaluation	Exam

Course Description

The purpose of the course is to provide an introduction to selected modern topics in numerical analysis. Upon completion of the course, students will have a basic understanding of various numerical methods, both in theory and practice. They will be able to write computer code for the algorithms they study and solve practical problems using them.

Numerical Analysis II

Semester	Spring
Subject code	P-ITMAT-0031
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	Mihály Kovács
End-term evaluation	Exam

Course Description

Numerical integration in 1D, simple quadrature rules, Euler's method and the theta method for ODEs, multistep methods, Runge-Kutta methods, error control: the Milne device and embedded Runge-Kutta methods, numerical methods for stiff problems, finite difference and finite element methods for boundary value problems of elliptic PDEs in 1D and multiple dimensions, the notions of stability and convergence, and the finite element method for parabolic and hyperbolic problems in 1D and multiple dimensions.

Numerical Methods of Quantum Mechanics

Semester	Autumn
Subject code	P-ITMAT-0046
ECTS credit value	5 credits
Number of classes per week	Lecture: 1 / Practice: 3 / Lab: 0
Recommended level of study	MSc
Lecturer	Mihály Kovács
End-term evaluation	Practical mark

Course Description

na.

Optical Devices and Photonics

Semester	Spring
Subject code	P-ITEEA-0051
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Exam

Course Description

The class provides an introduction to classical (electromagnetic) optics, while the second half of the semester is devoted to photonics, quantum optics, and the quantum theory of light. Optical devices are described using various models. Lab exercises include problem solving and several hours of experiments using a Michelson interferometer.

Optical Measurements, Microscopy and Imaging Techniques

Semester	Autumn
Subject code	P-ITEEA-0055
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Ádám Papp
End-term evaluation	Exam

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

The course presents the physical background of optical measurement and imaging techniques, primarily through examples from nano systems and medical diagnostics. It also covers, in less detail, non-optical methods used for the characterization of nano systems.

Optimization Methods

Semester	Spring
Subject code	P-ITMAT-0041
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	Miklós Ruszinkó
End-term evaluation	Exam

Course Description

Undoubtedly, artificial intelligence, combined with deep learning, is one of the most rapidly developing areas in computer science. On the other hand, optimization methods, such as the gradient method, have been well known for decades. Still, the theoretical background of this discipline is not fully explored. This course will introduce some classical optimization methods and highlight their relevance in artificial intelligence.

Parallel Computing Architectures

Semester	Autumn

Subject code	P-ITEEA-0022
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Szolgay
End-term evaluation	Exam

Course Description

Computing models: Basics of computer architectures and physical limits. Von Neumann architecture, Harvard architecture, integration of sensors. Digital signal processors – fixed-point implementations, floating-point architectures, fast buses and processing, SCSI processors, FPGA-based processor implementations, parallel processor architectures, and instruction types of parallel processing. Instruction-level parallel processors, pipeline processors. Design case study – design of an emulated digital CNN chip. Data-parallel processors, structure of a cell processor, systolic architectures, vector architectures, and MIMD architectures.

Parallel Programming

Semester	Spring
Subject code	P-ITSZT-0048
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 3
Recommended level of study	MSc
Lecturer	István Reguly
End-term evaluation	Practical mark

Course Description

Students will learn about parallel hardware and parallel programming methods, including shared memory parallelism and distributed memory parallelism on traditional CPUs, as well as programming graphical processing units (GPUs). The course covers the following topics:

1. C language recap. Basic concepts: parallelism and concurrency, decomposition and scheduling strategies, Amdahl's Law and Gustafson's Law;
2. Shared memory parallelism: OpenMP, data parallelism;
3. Shared memory parallelism: hardware, cache, coherency, task parallelism;
4. Distributed memory parallelism: CSP model, MPI, synchronous operations;
5. Distributed memory parallelism: asynchronous operations, collectives;
6. Performance modeling: metrics, bandwidth, computational throughput, latency;
7. Parallel scientific computations: dense and sparse linear algebra, partial differential equations;
8. GPU programming: OpenACC, memory spaces, data movement between CPU and GPU;
9. GPU programming: CUDA, blocks, registers, local (shared) memory, reductions, atomics – resource-constrained environments;

10. Programming heterogeneous architectures with OneAPI and SYCL: comparison to CUDA, utilizing various CPU and GPU architectures.

Parameter Estimation

Semester	Spring
Subject code	P-ITMAT-0026
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Gábor Szederkényi
End-term evaluation	Exam

Course Description

In this course, students are guided through a series of software design problems. They are required to develop multiple solutions and discuss their ideas in a constructive, collaborative manner. This approach leads them to discover software design patterns independently. The course covers all the patterns listed in the original *Design Patterns* book (see the recommended literature section). These include: Abstract Factory, Builder, Singleton, Factory Method, Prototype, Lazy Initialization, Wrapper/Adapter, Bridge, Composite, Decorator, Facade, Flyweight, Proxy, Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, and Visitor.

At the end of the semester, we cover some patterns from the field of concurrent programming. The specific patterns covered are decided during the semester based on student interest and problems encountered in the assignments.

Pharmacology

Semester	Autumn
Subject code	P-ITMED-0014
ECTS credit value	4 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Klára Tóth Pálné Gyires
End-term evaluation	Exam

Course Description

The course covers the following topics:

1. Basic pharmacology: pharmacodynamics, pharmacokinetics
2. Pharmacology of the autonomic nervous system (sympathetic, parasympathetic)

3. Pharmacology of the central nervous system (sedative-hypnotics, anxiolytics, antidepressants, antipsychotic agents, local and general anesthetics)
4. Cardiovascular pharmacology (pharmacology of ischemic heart disease, hypertension, cardiac failure, diuretics)
5. Pharmacology of endocrinology (adrenals, contraceptives)
6. Pharmacology of pain and inflammation (opioid and non-opioid analgesics, non-steroidal anti-inflammatory drugs)
7. Pharmacology of the gastrointestinal tract (pharmacology of gastric ulcers and inflammatory bowel diseases).

Physical Biology of the Living Cell I

Semester	Spring
Subject code	P-ITMED-0005
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Miklós Kellermayer
End-term evaluation	Exam

Course Description

The course covers the following topics: qualitative and quantitative modeling in biology; formation of biological structures; structural hierarchy of proteins; stability of biological structures; experimental methods for studying biological structures; microscopy studies of intracellular structures; super-resolution microscopy; dynamic intracellular protein structures; single-molecule biological activity.

Physical Biology of the Living Cell II

Semester	Autumn
Subject code	P-ITMED-0006
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Miklós Kellermayer
End-term evaluation	Exam

Course Description

The course covers the following topics: diffusion, polymerization, reptation; motor proteins, processes far from equilibrium; second law of thermodynamics in small systems, Evans-Searles

fluctuation theorem; Crooks fluctuation theorem, Jarzynski equality; thermodynamics of molecular motors; microscopy of motor proteins – laboratory demonstration; protein structure prediction and use of structural databases; molecular dynamics modeling; thermodynamic characterization of protein–protein and protein–ligand interactions.

Physics of Computing I

Semester	Autumn
Subject code	P-ITFIZ-0019A
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Exam

Course Description

na.

Physics of Computing II

Semester	Spring
Subject code	P-ITFIZ-0019B
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	András Horváth
End-term evaluation	Exam

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

na.

Physics of Information Technology and Bionics II

Semester	Autumn
Subject code	P-ITFIZ-0007
ECTS credit value	5 credits

Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	György Csaba
End-term evaluation	Exam

Course Description

The first half of the course will cover wave mechanics and the principles of quantum mechanics. Key applications of these concepts in chemistry and solid-state physics will be demonstrated. Some of the topics include: the Bohr model of the atom; wave-particle duality of light; interference and collision; particle-wave duality of the electron; Louis de Broglie waves; the nature of the matter-wave as a complex-valued wave function with a probabilistic interpretation of its absolute square; particles and waves – the free-particle Schrödinger equation; the Schrödinger theory of quantum mechanics; the time-dependent and time-independent Schrödinger equations; quantum mechanical expectation values; qualitative interpretation of wave functions; the periodic table of the elements; molecules and the chemical bond; Hückel theory and molecular modeling; a single electron in the electrostatic field of a one-dimensional periodic potential; the Kronig–Penney model and the concept of allowed and forbidden energy bands; intrinsic semiconductors – electrons and holes; light amplification by stimulated emission of radiation (LASER); three-level and four-level lasers; photodetecting devices and semiconductor lasers.

The course also includes an introduction to quantum electrodynamics (QED), superconducting quantum circuits, elements of nuclear physics, and the principles of cosmology and extragalactic astronomy.

Printed Circuit Board Design Practice

Semester	Autumn
Subject code	P-ITEEA-0017
ECTS credit value	3 credits
Number of classes per week	Lecture: 1 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Péter Szolgay
End-term evaluation	Practical mark

Course Description

This course introduces the fundamentals of printed circuit board (PCB) design using computer-aided design (CAD) tools. It provides an overview of the PCB design process, from high-level design to final output and manufacturing. Topics include packaging and interconnection structures, as well as mechanical, electrical, and manufacturing design considerations. Students will learn to interpret schematics, select appropriate components, arrange them on the board, and export the necessary files for fabrication.

Programming Methodology

Semester	Autumn
Subject code	P-MIM_T4A
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Gergely Feldhoffer
End-term evaluation	Exam

Course Description

The course covers fundamental concepts and methods for formal program design and verification. Topics include problem specification, abstraction levels, abstract data types, program description tools, and programming theorems. Students will learn how to transform programs systematically and apply techniques for proving algorithm correctness.

Programming of Quantum Computers

Semester	Spring
Subject code	P-ITSZT-0065
ECTS credit value	5 credits
Number of classes per week	Lecture: 0 / Practice: 4 / Lab: 0
Recommended level of study	MSc
Lecturer	Ádám Papp
End-term evaluation	Practical mark

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

na.

Project Fundamentals

Semester	Spring
Subject code	P-ITKOZ-0016
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	András Bojárszky

END-TERM EVALUATION	EXAM

COURSE DESCRIPTION

This course introduces students to the fundamental concepts of project management, including project roles, life cycles, and the definition of project success. Emphasis is placed on project competencies, supporting processes, and methodologies used in IT development projects. Students will also gain insight into areas influencing project implementation—such as finance, law, and marketing—as well as project planning, resource management, financing, quality assurance, and controlling. The course concludes with an overview of both predictive and agile approaches, illustrated through real-life case studies.

PROTEOMICS

SEMESTER	AUTUMN
SUBJECT CODE	P-ITMED-0032
ECTS CREDIT VALUE	3 CREDITS
NUMBER OF CLASSES PER WEEK	LECTURE: 1 / PRACTICE: 0 / LAB: 1
RECOMMENDED LEVEL OF STUDY	MSC
LECTURER	BALÁZS LIGETI
END-TERM EVALUATION	EXAM

REMARK

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

COURSE DESCRIPTION

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QUALITY ASSURANCE

SEMESTER	AUTUMN
SUBJECT CODE	P-ITKOZ-0008
ECTS CREDIT VALUE	2 CREDITS
NUMBER OF CLASSES PER WEEK	LECTURE: 1 / PRACTICE: 0 / LAB: 0
RECOMMENDED LEVEL OF STUDY	MSC
LECTURER	FRANCISKA VIDÁNÉ DR. ERDŐ
END-TERM EVALUATION	EXAM

Course Description

Working in compliance with quality assurance (QA) systems is essential for entering and maintaining a presence in the international market. This course provides an overview of the applications of QA across various fields, with a focus on biotechnology, drug research and development, and the pharmaceutical industry. Following a historical introduction, students will gain a comprehensive understanding of QA processes, quality control, and quality management.

Quantitative and Medical Biochemistry

Semester	Spring
Subject code	P-ITMED-0001
ECTS credit value	5 credits
Number of classes per week	Lecture: 3 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	Kraszimir Kolev
End-term evaluation	Exam

Course Description

The course provides a concise overview of dynamic cellular metabolic networks, emphasizing general principles of enzyme kinetics and the structure and regulation of metabolic pathways. Key topics relevant to future biotechnology specialists include modern biochemical techniques for analyzing intermolecular interactions and enzyme activity, as well as in silico modelling of biochemical systems. A medical perspective is introduced through discussions on the molecular basis of major public health diseases (e.g., cardiovascular and neurodegenerative disorders), with a focus on therapeutic molecular targets. The course combines formal lectures, tutorials, and computer-simulated practical sessions.

Quantitative Biology

Semester	Spring
Subject code	P-ITBIO-0052
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Attila Csikász-Nagy
End-term evaluation	Exam

Course Description

This course highlights recent advances in systems biology, with a focus on evolution-related topics from both biological and computational viewpoints. Delivered by local and international

experts, it combines lectures and student-led journal clubs to provide an overview of key research directions in the field. The course is co-organized by Andrea Ciliberto and Attila Csikász-Nagy, with sessions held on Wednesdays from 15:00 to 16:30. Lectures are offered either online or in person, while all journal clubs take place in person.

The course consists of:

- Lectures by guest and faculty speakers
- Journal Clubs where students present and discuss selected research papers Grades are based on journal club presentations and participation in discussions.

Topics:

- Introduction to adaptive evolution (Andrea Ciliberto)
- Measuring fitness and growth in laboratory evolution (Paolo Bonaiuti)
- Population genetics (Simone Pompei)
- Evolution of antibiotic resistance (Eszter Ari)
- Cancer as an evolutionary process (Gábor Boross)
- Evolutionary repair mechanisms (Marco Fumasoni)

Quantitative Modelling and Control of Nonlinear Molecular Processes

Semester	Spring
Subject code	P-ITJEL-0031
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Gábor Szederkényi
End-term evaluation	Exam

Course Description

The aim of this course is to emphasize the importance of system dynamics and control theory in understanding molecular biological processes. Students will be introduced to core concepts and tools from nonlinear systems and control theory, and will analyze biological case studies to explore the dynamics and regulation of key molecular processes. The course integrates theory and applications, with special focus on feedback, stability, and system-level design in cellular systems.

Course Topics:

1. Introduction: Modelling dynamical behavior and feedback in molecular systems; the role of dynamics and control in cellular function.
2. System Classes: Categories of dynamical systems and their descriptive properties.
3. Nonlinear Systems Theory: State-space properties—stability, observability, and controllability.
4. Feedback Linearization: Zero dynamics, relative degree, and linearization for SISO and MIMO systems.

5. Reaction Kinetic Networks I: Assumptions, representations, and biological examples.
6. Reaction Kinetic Networks II: Structure-dynamics relationships.
7. Reaction Kinetic Networks III: Designing kinetic networks to meet specified dynamic properties.
8. System-Theoretic Enzyme Kinetics: Regulation mechanisms, Michaelis-Menten and Hill kinetics, and the quasi-steady state assumption.
9. Gene Regulation and Protein Interaction Dynamics: Modelling transcriptional, translational, and protein interactions.
10. Regulatory and Signaling Modules: Dynamics of feedback loops, saturation effects, and oscillations in cellular systems.
11. Case Studies: G-protein coupled receptors, calcium dynamics, and electrophysiological connections.
12. Glucose-Insulin System: Modelling, regulation, and control analysis.
13. Metabolic Pathways: Analysis and design of energy-optimal regulatory strategies.

The course is ideal for students interested in systems biology, control engineering, and computational modeling of cellular processes.

Quantum and Bio Sensors

Semester	Autumn
Subject code	P-ITEEA-0054
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 1 / Lab: 1
Recommended level of study	MSc
Lecturer	Zsolt Szabó
End-term evaluation	Exam

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

na.

Recombinant DNA Techniques

Semester	Spring
Subject code	P-ITMED-0008
ECTS credit value	6 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Csaba Barta

End-term evaluation	Exam

Course Description

This course introduces the fundamental principles and modern applications of recombinant DNA technology. Through lectures and hands-on laboratory work, students explore the techniques used to manipulate DNA and analyze gene function, with a focus on biomedical and pharmaceutical applications. Topics include the creation and use of DNA libraries, molecular hybridization, PCR-based genotyping, gene expression analysis, and genetic engineering in both prokaryotic and eukaryotic systems. The course also highlights landmark achievements such as the Human Genome Project and the development of recombinant insulin, and discusses emerging approaches like human gene therapy and bioinformatics tools.

Lecture Topics Include:

- Definition of recombinant DNA
- Genomic and cDNA libraries
- Molecular hybridization techniques
- The Human Genome Project and individual genome variation
- Gene identification and genome annotation
- Polymerase chain reaction (PCR) and targeted mutagenesis
- Gene expression platforms
- Cloning into bacteria
- Recombinant insulin as a case study
- Transgenic animals and animal cloning
- Applications in the pharmaceutical industry
- Human gene therapy
- Role of bioinformatics in recombinant DNA research

Laboratory Practicals Include:

- Preparation of genomic DNA and genotyping using PCR-RFLP, PCR-ASA, and real-time PCR
- Isolation and purification of plasmid DNA; restriction enzyme mapping
- PCR amplification and agarose gel electrophoresis of recombinant DNA fragments
- Protein expression in bacterial systems and in vitro translation

This course is recommended for students pursuing studies in biotechnology, molecular biology, bioengineering, or pharmaceutical sciences.

Scientific Python

Semester	Spring
Subject code	P-ITSZT-0063
ECTS credit value	3 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Borbála Novák

End-term evaluation	Practical mark

Course Description

The goal of this course is to provide a concise overview of Python technologies that enable efficient handling of scientific and engineering problems. Students will gain practical skills and knowledge applicable in a wide range of fields including artificial intelligence, image processing, data mining, natural language processing, mathematical modeling, and bioinformatics. The course focuses on Python libraries, tools, and programming techniques that support data analysis, algorithm implementation, and problem-solving in research and industry contexts.

Scrum Agile Development Methodology (Scrum agilis fejlesztési módszertan)

Semester	Spring
Subject code	P-MIM_D63
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	András Oláh
End-term evaluation	Practical mark

Course Description

Students interested in agile methods can refresh their methodological knowledge and peek into the reality of agile work through a two-day workshop, a supplementary one-day session, and a remote feedback session. The course is based on real-life examples and allows students to bring in their own ideas and experiences. Starting with an interactive theoretical introduction, students will have a chance to revitalize their knowledge about the core concept of agile development. However, challenging common practices and letting real-life examples speak for themselves are essential for embracing agile methods. Participants can apply previously discussed concepts and experience daily agile work via an intensive sprint simulation of the agile development cycle by going through all the relevant steps. The primary goal of the course is to enable participants to easily fit into an agile environment and to gain the necessary insight and courage to introduce agile techniques and processes from scratch in any (start-up or corporate) environment or even to set up and implement their own projects in an agile way.

Sensor Technologies and Biological Sensing (Szenzortechnika és biológiai érzékelés)

Semester	Autumn
Subject code	P-ITEEA-0049
ECTS credit value	2 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	György Cserey
End-term evaluation	Exam

Remark

The course will be offered for the first time in the 2025/26 academic year and will only run if a sufficient number of students register.

Course Description

During the course, students are introduced to modern sensor technologies, including biologically inspired solutions and continuously developing devices capable of measuring biological signals for diagnostic purposes. The course covers the measurement principles of these sensors, the origins of the measured modalities, their characteristics, and the technical challenges involved. One aim of the course is to showcase the latest technological advancements in sensing.

Sensory Robotics

Semester	Spring
Subject code	P-ITEEA-0039
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	György Cserey
End-term evaluation	Exam

Course Description

The course covers the following topics:

1. Introduction – sensors. Motivation and parallelism with biology; sensing categories, proprioception, exteroception, exproprioception; reviewing the history of robotic sensors from the 70s, sensor revolution, state-of-the-art robotics, challenges and future of sensors;
2. Human sensing and sensors in biology. Mechano-, thermo-, and nociceptors; fast-slow adaptation; touch; pain; balancing; vision; visual-tactile-motor mechanisms; hearing;

smell and taste; sensing the inner state; special sensors in biology: localisation (e.g., birds and salmon), distance measurement (e.g., owl, bat, whale);
3. Behaviour-based robotics, introducing behaviour methods in robotics, deliberative and reactive systems, description and coding of behaviours, behaviour design and coordination, design decisions;
4. Behaviour coordination, emergence, fusion, and synchronization methods of behaviours;
5. Sensor characteristics; basic principles through examples; sensitivity; accuracy; dynamic range; hysteresis; nonlinearity; resolution; environmental factors; special properties; transfer function; approximations; interpolation; calibration;
6. Sensors, general properties: distance measurement sensors, sensors for localization and navigation, impact, touch, pressure and force measurement, temperature and measuring internal state;
7. Sensor arrays and sensor networks, visual perception – machine vision, depth cameras, motion tracking systems;
8. Sensor fusion, connection of human and machine sensing;
9. Sensors of a mobile robot, sensors of a humanoid robot, remotely controlled robotics;
10. The sensors and measurement methods of the Curiosity rover on Mars.

Signal Transduction

Semester	Autumn
Subject code	P-ITMED-0011
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Szabolcs Sipeki
End-term evaluation	Exam

Course Description

The course covers the following topics: Principles of signal transduction (classification of receptors, main signaling routes, reversible protein phosphorylation). Protein domains in signal transduction. Signaling with cAMP (adenylyl cyclase, protein kinase A, CREB transcription factor). Signaling with phosphoinositide derivatives (phospholipase C, protein kinase C, PI 3-kinase, protein kinase B). Receptor protein tyrosine kinase signaling. Signaling through the insulin receptor, diabetes mellitus. Non-receptor tyrosine kinase signaling. Signal transduction to and from adhesion molecules (integrins). NF-kappaB signaling. TGF-beta signaling. The regulation of the cell cycle (oncogenes, tumor suppressor genes). Programmed cell death (the survival signal, mechanisms of apoptosis). Molecular basis of tumorigenesis.

Social and Economic Impacts of Quantum Technologies

Semester	Autumn

Subject code	P-ITKOZ-0013
ECTS credit value	3 credits
Number of classes per week	Lecture: 1 / Practice: 1 / Lab: 0
Recommended level of study	MSc
Lecturer	Zsolt Szabó
End-term evaluation	Practical mark

Course Description

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Software Defined Electronic and Information Systems

Semester	Spring
Subject code	P-ITEEA-0040
ECTS credit value	4 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Géza Kolumbán
End-term evaluation	Exam

Course Description

Complex, up-to-date ICT and test systems are implemented in software. These complex systems, including many remotely controlled devices and equipment, are embedded into a computing environment. This subject will teach the theory and practice of software-based implementation, the system-level analysis and design of very large ICT and test systems, and the methods used in remote control.

Software Test Automatization in Practice

Semester	Autumn
Subject code	P-ITJEL-0029
ECTS credit value	2 credits
Number of classes per week	Lecture: 0 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	András Oláh
End-term evaluation	Practical mark

Remark

Course offered by EPAM

Course Description

Software testing and test automation are essential parts of the software development process and methodologies (Agile, Scrum, XP, etc.). The aim of the course is to enable students to learn the main tools and techniques (TDD, DDT, Unit testing, Mocking, Web UI testing, Selenium, Docker) used in the test automation process through hands-on practice.

The course covers the following topics:

- Version control systems (GIT);
- Unit testing (basics, DDT, and mocking);
- API testing (basics);
- Continuous integration;
- Web UI testing (basics, key parts of a framework, page object usage);
- Docker (container-based software development and testing).

Solid State Electronic Devices and Sensors

Semester	Autumn
Subject code	P-ITEEA-0053
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 2 / Lab: 0
Recommended level of study	MSc
Lecturer	Péter Földesy
End-term evaluation	Exam

Course Description

na.

Stem Cell Biology

Semester	Spring
Subject code	P-ITMED-0010
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 0
Recommended level of study	MSc
Lecturer	Balázs Mayer
End-term evaluation	Exam

Course Description

Stem cell biology is currently one of the most intensely studied areas of biomedical research, and our knowledge of stem cells is constantly growing every day. During the lectures, we provide

an introduction to different types of stem cells, clinical research data, recent results, and challenges in the field. Emphasis will be placed on the critical evaluation of information about stem cells, stem cell banking, and stem cell treatments.

Stochastic Signals and Systems

Semester	Autumn
Subject code	P-ITMAT-0037
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Zsuzsanna Gerencsérné Vágó
End-term evaluation	Exam

Course Description

Wide-sense stationary processes; orthogonal processes and their transformations; prediction, innovation, and the Wold decomposition; singular processes; spectral theory; random orthogonal measures; representation of a wide-sense stationary process; AR, MA, and ARMA processes; multivariate time series; state-space representation; Kalman filtering; identification of AR processes; identification of MA and ARMA models; non-stationary models; stochastic volatility: ARCH and GARCH models.

Systems Bioinformatics

Semester	Autumn
Subject code	P-ITBIO-0048
ECTS credit value	3 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Balázs Ligeti
End-term evaluation	Exam

Course Description

Advanced course in systems bioinformatics. The aim of the course is to provide deeper, hands-on knowledge in the fields of bioinformatics working with big data, from a systems biology perspective, especially dealing with large-scale sequencing data. DNA sequencing topics include metagenomics, exome sequencing, RNA-seq, etc. The course does not focus only on sequence data but also on various complex network representations (including hierarchical networks) of the data. Another important aspect of the course is to provide insight into basic

text mining tools to understand texts as one of the most important layers of data networks. The course emphasizes understanding and designing complex pipelines.

The Finite Difference Time Domain Method for Engineers

Semester	Autumn
Subject code	P-ITFIZ-0011
ECTS credit value	4 credits
Number of classes per week	Lecture: 3 / Practice: 0 / Lab: 1
Recommended level of study	MSc
Lecturer	Zsolt Szabó
End-term evaluation	Exam

Course Description

Nowadays, engineers' daily activities widely involve the use of various software packages. This enables full prototyping through computer software, with the desired products fabricated with high reliability as the final step only. These lectures introduce the Finite Difference Time Domain Method (FDTD), which is the most efficient electromagnetic design algorithm. The FDTD method allows the design of many devices ranging from microwave to optical frequencies. Telecommunication antennas, medical instruments such as MRI, multilayers that act as mirrors for high-intensity lasers, optical sensors, or even the full electromagnetic compatibility analysis of a vehicle are a few examples where FDTD has been successfully applied.

VLSI Design Theory and Practice

Semester	Autumn
Subject code	P-ITEEA-0041
ECTS credit value	5 credits
Number of classes per week	Lecture: 2 / Practice: 0 / Lab: 2
Recommended level of study	MSc
Lecturer	Péter Földesy
End-term evaluation	Exam

Course Description

Integrated Circuits are everywhere. This course provides a deep introduction to IC design, covering the manufacturing process, development costs, analog and digital design flows, 3D IC variants and their roles in integration, packaging options, DIY chips, and other important and interesting details.

Besides the design background, we analyze the most advanced chips today, including deep learning neural inference accelerators, GPUs, TPUs, FPGAs, low-power IoT microcontroller architectures, and microelectronic technological solutions to provide a broad view of the current industry landscape.

To complete the course, students are required to give a short presentation of their own field from the perspective of IC technology.