EÖTVÖS LORÁND UNIVERSITY
DOCTORAL SCHOOL OF INFORMATICS

EDUCATIONAL PLAN

Discipline:	Informatics / computer science
Level:	Doctoral (PhD)
Aim of the programme:	to prepare students for the obtainent of a doctoral degree
Duration of the program:	8 semesters (the training and research and the research and dissertation phases)
Type of the program:	full-time education
Finances:	limited number of state scholarships, otherwise tuition fee
Entry requirement:	MSc/MBA/MA degree and successful entrance examination
Language requirements:	one complex (B2) intermediate level state-accredited language exam
Certificate at the end of the training:	pre-degree certificate
Full credit requirements:	240 credits
Ways of credit acquisition:	Study credits (min.: 24, max.: 54), teaching credits (min.: 0, max.: 48), research credits (min.: 156, max.: 216), professional credits (min:: 0, max: 24). The number of the required credits that must be fulfilled by the 4th semester are 120, as stated in the ELTE Doctoral Regulations. By the end of the fourth semester, it is mandatory to take and complete a course that includes the subjects of the student's comprehensive exam, so-called comprehensive exam preparatory course. Taking a comprehensive (complex) exam is mandatory at the end of the fourth semester. After a successful comprehensive exam, study credits cannot be awarded in the research and dissertation phase.

The doctoral programme consists of the training and research (from the first to the fourth semesters) and the research and dissertation phases (from the fifth to the eighth semesters).

The doctoral training programs of the Doctoral School

- Doctoral School of Informatics/Doctoral Program of Software and Computer Science
- Doctoral School of Informatics/Doctoral Program of Data Science, Networks, Information Systems
- Doctoral School of Informatics/Doctoral Program of Scientific Computing and Models, Numerical and Symbolic Methods
- Doctoral School of Informatics/Doctoral Program of Informatics Teaching Methodology
- Doctoral School of Informatics/Doctoral Program of Geospatial Information and Spatial Data
- Doctoral School of Informatics/Doctoral Program of IT Solutions in Engineering Sciences

I. Doctoral Program of Software and Computer Science

The aim of the doctoral program is to provide doctoral students with deep and wide-ranging knowledge that will enable them to cultivate the theoretical foundations of computing and software science in an effective and active way, furthermore, to apply the methodological principles in an innovative manner, and adopt new procedures.
The program offers the following research topics:
software design and software engineering, algorithms, programming paradigms, programming

languages and type theory, software reliability, analysis, correctness, and testing, software architectures, computational models and unconventional computing, quantum computing, artificial intelligence models and their application in the production of intelligent software, application domain-specific programming languages and software-intensive systems, cyber-physical and autonomous systems, human-machine interaction and natural language processing, and human and social aspects of information technology.

II. Doctoral Program of Data Science, Networks, Information Systems

The doctoral program is concerned with the theoretical research, construction, operation, and use of computer technologies for the operation of the digital data world. The three pillars of the doctoral program, data science, computer networks, and original information systems, support each other and provide a wide range of research opportunities.

- The increasingly abundant availability of data and processing capabilities has led to the emergence of the field of data science, enhancing previous data mining and big data technologies with new deep learning capabilities in Artificial Intelligence. In summary, the field of managing, analyzing, and using big data sets is called data science. This includes data collection, cleaning, storage, and related algorithms, as well as data mining and deep learning technologies for analysis.
- In addition to data management, the research of digital data networks for data collection, flow, access, and communication is the second component of the program. Networks will connect cloud centers to server centers, end users to individual mobile devices, and sensor networks to the Internet of communicating smart objects, extending the connectivity of our world across a very broad spectrum.
- In the area of information systems, the program focuses on new directions in classical system models and operational database management technologies. Research in new concepts for data models, knowledge representation, and new database management technologies is also linked to this area. A key feature of digitization is that information systems are being built and enhanced with increasing automation and integration of AI technologies. Methods, algorithms, and technologies collectively referred to as artificial intelligence, and advanced data analytics solutions, are emerging, integrated, and embedded in processes within organizations and related information system processes. From these processes, the immutability of the outcomes of decisions and actions, the development of formal and feasible models and methods for transparency, traceability, explainability, and the exploration of alternative approaches and solutions are promising research areas.

III. Doctoral Program of Scientific Computing and Models, Numerical and Symbolic Methods

In the field of Scientific Computating and Models, the doctoral program deals with the construction of mathematical models using the tools of harmonic analysis, differential equations, number theory, and computer graphics, with the aim of solving problems in computer science, medicine, engineering, and other fields. In the area of numerical and symbolic methods, the doctoral program is structured around the theory and practice of numerical methods, approximation theory and optimization, and the mathematical background, methods, and applications of symbolic computation. Research in various related disciplines applying scientific computing, numerical or symbolic methods can also be included in the doctoral program. A wide range of topics such as signal and image processing, medical applications, engineering, shape recognition, computer vision, computer algebra applications, cryptography, and information security are being addressed.

IV. Doctoral Program of Informatics Teaching Methodology

The aim of the doctoral program is to train research teachers with a broad knowledge of computer science, who are able to combine the discipline, its new findings, and pedagogical knowledge in a creative way, and who are able to perform demanding tasks in teaching, talent management, curriculum design and development, subject advising and subject management, as well as to provide a supply of new talent in the field of subject methodology in higher education. Research in educational methodologies needs to respond rapidly to a constantly changing knowledge base and to the impact of information technologies that are increasingly embedded in everyday life. The

subject of informatics is changing very rapidly, with an increasing emphasis on programming alongside general informatics, as evidenced by the intensity of curricular debate at the international level. It is therefore essential for researchers to keep pace with the emergence of modern technologies and tools, not only at the user level but also with a broad, professional knowledge of programming. This complex task cannot be achieved without specific research skills.

V. Doctoral Program in Spatial Information and Spatial Data Science

Spatial data plays a critical role in the digitalization of social and industrial domains and is a fundamental input parameter for various economic and research concepts. The successful utilization of location-based content, which includes spatial, temporal, and thematic data, is an indicator of significance from both scientific and economic perspectives. In addition, a substantial amount of human culture information is spatial data.
The doctoral program Spatial Informatics and Spatial Data Science is designed to analyze, interpret, and model spatial relationships of attribute data. It aims to develop a theoretical and practical understanding of spatial data technologies and their application, as well as research development to address the challenges in this field.
The program's thematic areas include remote sensing methods, web-GIS, navigation and mobile mapping technologies, spatial data visualization, spatial data mining, and other relevant topics in computer science.

VI. Doctoral Program of IT Solutions in Engineering Sciences

Modern production technologies are inconceivable without IT research and development nowadays. The comprehensive, complex understanding and management of it is the driving force of modern societies.
The educational perspective within the framework of the doctoral program enables the acquisition of comprehensive proficiency at the interface points of the IT and engineering fields. Based on this knowledge, the students enable to conduct independent research, develop IT solutions and solve problems arising in engineering sciences.
The doctoral program provides theoretical and practical knowledge in the fields of informatics, which are essential for high-quality engineering solutions, including Industry 4.0 manufacturing technology, engineering materials science, mechanics and dynamic flow simulations.
IT research and development focuses on tasks whose solution supports the characteristics and multipurpose, applied use of metallic, polymeric and composite materials. Materials science issues range from molecular systems through an array of material properties to informatics and engineering design, finite element modeling and optimization procedures with IT systems. The background of these and similar engineering solutions is based on engineering mechanics.
The infrastructural conditions of the doctoral program are based on the modern and well-equipped laboratories of the Savaria Institute of Technology within the Faculty of Informatics.

Training and research phase

In the training and research phase, students are required to complete at least 24, maximum 54 study credits.

The 6-credit courses include 2 contact hours per week.

Subjects and lecturers within the doctoral programs:

Doctoral Program of Software and Computer Science

Subjects:

INFPHD005 Software Quality Management
6 credit, lecture, optional, not repeatable
INFPHD008 Seminar on search and communicational complexity
6 credit, lecture, optional, not repeatable
INFPHD015 Research Topics in Autonomic Systems
6 credit, lecture, optional, not repeatable
INFPHD032 Type theory
6 credit, lecture, optional, not repeatable
INFPHD034 Analysis of Algorithms and Data Structures I.
6 credit, lecture, optional, not repeatable
INFPHD035 Comparative analysis of Programming Languages
6 credit, lecture, optional, not repeatable
INFPHD037 Artificial Neural Nets
6 credit, lecture, optional, not repeatable
INFPHD061 Research methodology
6 credit, practice, mandatory, not repeatable
INFPHD080 Systems of language processors: formal –language-theoretic models of multi-agent systems
6 credit, lecture, optional, not repeatable
INFPHD102 Bio-inspired Computation: Membrane Systems
6 credit, lecture, optional, not repeatable
INFPHD407 Software Testing
6 credit, lecture, optional, not repeatable
INFPHD426 Central-European Functional Programming Summer School
6 kredit, előadás, választható, nem ismételhető
INFPHD435 Current Trends in Logic Programming
6 credit, lecture, optional, not repeatable
INFPHD438 Requirements Engineering
6 credit, lecture, optional, not repeatable
INFPHD444 SAT Solving Algorithms
6 credit, lecture, optional, not repeatable

Comprehensive (complex) exam preparatory subjects:

INFPHD601 Design and analysis of algorithms (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD602 Complexity (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD604 IT security (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD609 Parallel and Distributed Systems (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD610 Programs correctness and semantics (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD612 Programming Languages (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD613 Theoretical Foundations of Computer Science (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD629 Mathematical Logic (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD631 Programming Technology (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD632 Temporal Logic (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable

Senior lecturers/lecturers:

Tibor Ásványi: Algorithms and data structures, Logic programming

Miklós Bíró: Mobile Learning National Cultures Software Process Improvement Software Engineering Group Decision and Negotiation Support Systems, Computer-Supported Cooperative Work Combinatorial Optimization

János Botzheim: computational intelligence, cognitive robotics, memetic algorithms

Péter Burcsi: Computer number theory, word combinatorics

Erzsébet Csuhaj Varjú: theoretical computer science, formal languages and automata, multi-agent systems, nature-motivated computer science

Tibor Gregorics:

Vince Grolmusz: mathematics and computer science, bioinformatics

Zoltán Horváth: functional and distributed programming

László Hunyadvári: Stochastic and fuzzy automata. Analysis and synthesis of fuzzy automata, their use in a fuzzy environment. Regulated transcriptions

Zoltán Illés: Mobile, web systems Operating systems of embedded systems Real-time systems, measurements and their control

Ambrus Kaposi: type theory

Gyula Katona: Extremal combinatorics; Databases; Cryptology

Zoltán Király: Graph theory, combinatorial optimization, computer science

Attila Kovács: Algorithmic number theory, Software quality, testing

Tamás Kozsik: programming languages; formal methods; program analysis and transformation; parallel, competitive and distributed computing

Gábor Kusper: SAT problem, formal methods, model checking

Péter Ligeti: Combinatorics of words: word sets, DNA sequence properties Cryptography: insertion-deletion codes, RFID systems, secure network coding, minimalist cryptography, secret sharing

András Lőrincz: Deal with intelligent systems. Keywords: human-computer-robot cooperation, cognitive science, neural systems, goal-oriented systems, distributed intelligence, educational games

Zoltán Porkoláb: Generative programming, C++ template metaprograms. Software complexity, multiparadigm-based software metrics. Programming languages, programming paradigms. Software understanding, visualization

László Szabó: geometry, discrete mathematics, computer science

Máté Tejfel: Correctness testing, functional programming, parallel programming

Márta Turcsányi-Szabó: Tools and methods of technology-assisted learning

László Zsolt Varga: IT, distributed systems, artificial intelligence, multi-agent systems, software technology

Viktória Zsók: functional programming, distributed systems, parallel programming, programming languages

List of complex exam subjects within the doctoral program:

Design and analysis of algorithms

Complexity theory

IT security

Parallel and distributed systems

Correctness and semantics of programs

Programming languages

Foundations of computational theory

Computer systems

Data structures and algorithms

Mathematical logic

Programming technology

Temporal logics

Doctoral Program of Data Science, Networks, Information Systems

Subjects:

INFPHD022 Advanced database systems II. (Fundamentals of Databases II-III.)
6 credit, lecture, optional, not repeatable
INFPHD023 Data mining
6 credit, lecture, optional, not repeatable
INFPHD037 Artificial Neural Nets
6 credit, lecture, optional, not repeatable
INFPHD048 Analysis of Algorithms and Data Structures II
6 credit, lecture, optional, not repeatable
INFPHD052 Queueing theory
6 credit, lecture, optional, not repeatable
INFPHD061 Research methodology
3 credit, practice, mandatory, not repeatable
INFPHD421 Mobil Ad Hoc Networks
6 credit, lecture, optional, not repeatable
INFPHD427 Peer-to-peer networks
6 credit, lecture, optional, not repeatable
INFPHD441 Semantic Web applications
6 credit, lecture, optional, not repeatable

Complex exam preparatory subjects:

INFPHD616 Data Mining (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD619 Bioinformatics (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD626 Information systems applications (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD628 Modern databases (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD633 Geoinformatics (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD636 Information systems (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD637 Databases and knowledge bases (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD638 Mathematics of networks and the www (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable

Senior lecturers/lecturers:

András Benczúr
Theory and applications of database systems. Information theory. Complexity theory. Modeling and planning of information systems. Stochastic systems

András Benczúr jr.
big data, data mining, information retrieval

János Botzheim

computational intelligence, cognitive robotics, memetic algorithms

István Csabai
astronomy, astrophysics, scientific databases, complex systems, complex networks, communication networks, bioinformatics, genomics, artificial intelligence

László Gulyás
Artificial Intelligence. Evolutionary Computations. Swarm intelligence. Multi-agent systems. Agent-based social simulations. Social networks. Intelligent systems.

Tomás Horváth
Data mining, Machine learning, Recommender systems, Personalization

Attila Kiss
Application of mathematical models in data science, artificial intelligence and database optimization, bioinformatics, data security, theoretical and practical issues of databases

Sándor Laki
Network algorithms, active network measurements and their data analysis including the areas of IP geolocation, traffic classification and analysis.

Imre Lendák
information security. data science, data technologies

András Lőrincz
Intelligent systems: human-computer-robot cooperation, cognitive science, neural systems, goal-oriented systems, distributed intelligence, educational games

Tamás Lukovszki: communication network algorithms, peer-to-peer networks, ad hoc networks, data compression, "external memory" algorithms, "computational geometry

Bálint Molnár: Modeling of information systems, methodologies, organizational / information architectures, Corporate management systems, process modeling, Big Data, complex systems, networks (graphs) and ontologies.

Gábor Tamás Orosz: Business IT

List of complex exam subjects for the doctoral program:

- Databases, knowledge bases
- Data mining
- Bioinformatics
- Modern databases
- Information systems
- IT security
- Artificial Intelligence

List of complex exam subjects recommended in the doctoral program:

- Parallel and distributed systems
- Basics of computation theory
- Computer graphics
- Computer systems
- Design and analysis of algorithms
- Data structures and algorithms
- Image processing (Computer vision)
- Neural computing
- Temporal logics
- Geospatial information
- Mathematics of www and networks

Doctoral Program of Scientific Computing and Models, Numerical and Symbolic Methods

Subjects:

INFPHD009 Surface reconstruction by computer
6 credit, lecture, optional, not repeatable
INFPHD061 Research methodology
6 credit, internship, mandatory, not repeatable
INFPHD167 Nonlinear phenomenon on lattice
6 credit, lecture, optional, not repeatable
INFPHD197 Multiple objective optimization
6 credit, lecture, optional, not repeatable
INFPHD413 Principles of real analysis
6 credit, lecture, optional, not repeatable
INFPHD423 Parallel computing in discrete mathematical modelling
6 credit, lecture, optional, not repeatable
INFPHD433 Fourier calculus I
6 credit, lecture, optional, not repeatable
INFPHD434 Fourier calculus II
6 credit, lecture, optional, not repeatable

Preparatory subjects for complex exams

INFPHD603 Fourier analysis and its applications (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD607 Numerical computations (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD618 Approximation theory (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD620 Numerical solution of differential equations (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD621 Numerical solution oft he equation system (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD622 Models of computation and their applications (complex exam preparatory)

6 credit, practice, mandatory chosen, not repeatable

INFPHD624 Mathematical modelling of Curves and Surfaces (complex exam preparatory)

6 credit, practice, mandatory chosen, not repeatable

Senior lecturers/lecturers:

Erzsébet Csuhaj-Varjú: theoretical computer science, formal languages and automata, multi-agent systems, nature-motivated computer science

Gábor Fábián: Curves and surfaces

Sándor Fridli: Harmonic analysis. Mainly trigonometric and Walsh-Fourier analysis. Approximation theory. Transformation methods in signal and image processing

Róbert Fullér: Fuzzy decision models, Hybrid intelligent systems, Fuzzy optimization, Mathematical modeling of industrial problems

Ágnes Fülöp: numerical modeling of nonlinear phenomena, chaos, fractal geometry, non-Abelian gauge theory on a grid, jet algorithms, quantum informatics, quantum entanglement

Lajos Gergó: Numerical methods of linear algebra, Numerical methods of differential equations, Fuzzy mathematics, Reliable numerical calculations

Péter Kovács: signal processing, numerical analysis, optimization

Sándor Kovács: Biomathematics, qualitative theory of differential equations

Anna Krebsz: Weighted polynomial interpolation

Lajos Lóczi: Differential equations

Zsolt Németh: Harmonic analysis, approximation theory, interpolation

Gábor Renner: computer geometric modeling and reconstruction

Péter Simon: Examination of Fourier series solutions according to special orthogonal systems

László Szili: approximation theory, differential equations

Toledo Rodolfo: Fourier analysis, approximation theory

Ferenc Weisz: Fourier series, Gábor analysis, approximation theory, martingale theory

List of complex exam subjects for the doctoral program:

- Fourier analysis and its applications
- Numerical calculations
- Approximation theory
- Numerical solution of differential equations
- Numerical solution of systems of equations
- Computational models and their applications
- Mathematical modeling of curves and surfaces

Doctoral Program of Informatics Teaching Methodology

Subjects:

INFPHD061 Research methodology
6 credit, practice, mandatory, not repeatable
INFPHD142 M-Learning
6 credit, lecture, optional, not repeatable
INFPHD156 R&D questions of innovative TEL (Technology Enchanted Learning)
6 credit, lecture, optional, not repeatable
INFPHD160 Theory of informatics curriculum
6 credit, lecture, optional, not repeatable
INFPHD179 Chapters of informatics methodology research seminar I.
6 credit, internship, optional, not repeatable
INFPHD184 Chapters of informatics methodology research seminar II.
6 credit, internship, optional, not repeatable
INFPHD185 Chapters of informatics methodology research seminar III.
6 credit, internship, optional, not repeatable
INFPHD190 Educational programming languages
6 credit, lecture, optional, not repeatable
INFPHD417 Research fields of interactive media
6 credit, lecture, optional, not repeatable

Complex exam preparation subjects:

INFPHD608 The teaching methodology of Information Technology (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD611 Programming methodology (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD615 Computer systems (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable

Senior Lecturers/Lecturers:

Márta Turcsányi-Szabó: E-Learning, Programming and research methodology, Technologies that help learning

Zoltán Illés: Operation systems, Real-time systems, Programming languages

Győző Horváth: Web systems - Programming methodology

Andor Abonyi-Tóth: Web systems, Barrier-free web design, Programming methodology

Viktória Bakonyi: Real-time systems, Programming methodology, Programming languages

Péter Bernát: Programming methodology, School programming languages

List of complex exam subjects for the doctoral program:

- Methodology of teaching Informatics
- Programming methodology
- Computer systems
- Information technology curriculum theory
- Technologies that support teaching

List of complex exam subjects recommended in the doctoral program:

- Databases, knowledge bases
- Information systems
- IT security
- Artificial Intelligence
- Numerical calculations
- Methodology of teaching Informatics
- Parallel and distributed systems
- Programming methodology
- Programming languages
- Computer graphics
- Computer systems
- Information technology curriculum theory
- Technologies that support teaching

Doctoral Program in Spatial Informatics and Spatial Data Science

Subjects:

INFPHD061 Research methodology
6 credit, practice, mandatory, not repeatable
INFPHD… Developing web applications with maps
6 kredit gyakorlat, választható, nem ismételhető
INFPHD… Remote sensing methods
6 kredit előadás, választható, nem ismételhető
INFPHD… Map animations
6 kredit gyakorlat, választható, nem ismételhető
INFPHD… Cognitive Data Visualization
6 kredit előadás, választható, nem ismételhető
INFPHD… Spatial Databases and Data Mining in Geoinformatics
6 kredit gyakorlat, választható, nem ismételhető
INFPHD... Output-oriented digital cartography
6 kredit előadás, választható, nem ismételhető

INFPHD... Thematic Maps in GIS
6 kredit gyakorlat, választható, nem ismételhető

Complex exam preparation subjects:

INFPHD… Remote sensing methods
6 kredit előadás, kötelezően választható, nem ismételhető
INFPHD… Developing web applications with maps
6 kredit gyakorlat, kötelezően választható, nem ismételhető
INFPHD... Output-oriented digital cartography
6 kredit előadás, kötelezően választható, nem ismételhető
INFPHD… Cognitive Data Visualization
6 kredit előadás, kötelezően választható, nem ismételhető
INFPHD… Spatial Databases and Data Mining in Geoinformatics
6 kredit gyakorlat, kötelezően választható, nem ismételhető

Senior Lecturers/Lecturers

István Elek
Topological data structure research, IT problems of large map databases, texture-based segmentation, digital evolution modeling

Mátyás Gede
web cartography, web geospatial information, globe digitization, virtual globes

János Györffy
Projections of geocartography (world projections, projections with optimal distortion, degree network rotation transformations); geodesy projections in GIS (projection conversions, distortions)

András Jung
Application and development of high-resolution remote sensing, imaging and field spectroscopy in plant and soil research.

Krisztina Irás
Thematic cartography, GIS, map history

Krisztián Kerkovits
Projection theory, numerical problems in cartography, geodesy, projections with least distortion

Béla Kovács
GNSS GPS cartography, digital cartography, GIS

Reyes Nunez José Jesús
Digital cartography: computer-based map editing, map-based animations, web cartography. Geovisualization. Maps of Mesoamerica.

Zsolt Győző Török
Cognitive cartographic visualization, eye movement tracking. Theoretical cartography. History of cartography-map history (Renaissance cosmography, Enlightenment cartography, colonial cartography).

Zsuzsanna Ungvári
Automation of map generalization, GIS, spatial databases

László Zentai
cartography (computer cartography, topographic maps, topography, web cartography)

List of complex exam subjects for the doctoral program:

- Geospatial information
- Navigation technologies
- Remote sensing
- Spatial data visualization

List of complex exam subjects recommended in the doctoral program:

- Spatial databases and data mining
- Map projections in GIS

Doctoral Program of IT Solutions in Engineering Sciences

Subjects:

INFPHD061 Research methodology
6 credit, practice, mandatory, not repeatable

Complex exam preparatory subjects:

INFPHD Engineering application of information theory and entropy (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD Manufacturing engineering for I4.0 (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD Computation engineering process (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD Modelling and Simulation of Dynamic Systems (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable
INFPHD Multicriteria decision making (complex exam preparatory)
6 credit, practice, mandatory chosen, not repeatable

Senior lecturers/lecturers:

Levente Csóka: Materials Science and Engineering

László Kollár: Materials Science and Engineering

Sidor Jurij Materials Science and Engineering

Mátyás Andó: Material development for the plastics industry. Tribology. Production, machining

Gusztáv Fekete: Kinetics and kinematics of the joints of the lower limb (ankle-knee). Investigation of wear in knee implants using multibody dynamic models. Development of biocomposites for agro-technical use

Singh Tej: Materials Science and Engineering

Rules for evaluation and assessment:

During the training and research phase, credit points can be given for attending contact classes, for exams, for the preparation of the accomplishment of tasks and for the absolving of assessments. In the case of one-semester courses taught in one or two contact hours a week, the evaluation of the processing and acquisition of the knowledge material is carried out on a five-level scale: excellent (5), good (4), satisfactory (3), pass (2) and fail (1). In the case of some two-semester subjects, the first semester of which does not end with an assessment, at the end of the first semester, the instructor evaluates the student's performance on a two-level scale - passed or failed - with the signature of the instructor. In this case, students only receive grades and study credits at the end of the second semester, after completing the second part of the subject based on a five-point scale.

The minimum number of study credits that must be acquired in the training and research phase is 24. Among the courses that can be taken, we distinguish the so-called courses belonging to the doctoral program, complex exam preparatory subjects and complex exam preparatory subjects recommended in the doctoral program. By the end of the fourth semester, it is mandatory to take at least one complex exam preparatory course, related to the student's complex exam subject.

Mandatory subjects in the training and research phase:

Research methodology (1st semester, 6 credits)
Main subject preparing for complex exam (2^{nd} to 4^{th} semesters, 6 credits)

INFPHD500 Partial training, credit transfer
A maximum of 50% of the study credits required to obtain the pre-degree certificate (absolutorium) can be completed through partial training or credit transfer.

Research credits: the minimum research credits to be completed in the two phases are 156, the maximally acquirable research credits are 216.

Distribution: 1-4 semester: minimum 66 credits, maximum 96 credits
5-8 semester: minimum 90 credits, maximum 120 credits

INFPH D200 Supervised research work

1-4 semester: minimum 66 credits in total, maximum 96 credits in total
5-8 semester: minimum 90 credits in total, maximum 120 credits in total,
practice, mandatory

Mandatory research assignments:

Preparation of a detailed research plan, end of the 1st semester, 2 credits
Preparing a research report 1-3, 5-8. end of semester, 2 credits

The system of recognition of research performance:

Research credit can be given for acquiring the abilities and skills necessary for scientific research work, for making progress in scientific research work, and for publishing the results of scientific work.

Proposal for detailing research credit points:
(recognized by the supervisor with the approval of the head of the doctoral program in proportion to the amount of the work invested):

Recommended amount for completing tasks:

- Professional presentation: 2-4 credits
- Presentation with a paper published at a domestic conference: 4-5 credits
- Poster at a domestic conference: 3-4 credits
- Presentation with a paper published at an international conference: 6-10 credits
- Poster at an international conference: 4-8 credits
- Technical article published in Hungarian: 4-8 credits
- Technical article published in a foreign language: 8-14 credits

Research activity without concrete results:
It must be recognized in proportion to the amount of work invested (1 credit equals to 30 working hours), a maximum of 20 credits can be given during a semester for carrying out research activities without concrete results.

Within the scientific module, credit points can be awarded for acquiring the abilities and skills necessary for scientific research work, for progressing in scientific research work, and for publishing the results of scientific work. The research activity to be carried out is evaluated on a three-level scale (excellent, pass, fail). At the end of each semesters, the supervisor verifies the student's research results by filling in a credit verification form and determines the credit value of professional presentations, presentations held at domestic and foreign conferences and published posters, as well as accepted and published technical articles in Hungarian and foreign languages.

Research activities that do not lead to specific results are classified by the supervisor in proportion to the amount of work invested. The interpretation of research activity that does not involve a specific result: all research activities that lead to the solution of a given scientific problem and the publication of the solution (e.g. processing literature, making assumptions, proposed solutions and checking their correctness, preparing the result for publication). The doctoral student must prepare a 3 to 5 page report on the research activity that does not lead to specific results, which is approved by the supervisor's signature and countersigned by the head of the doctoral program.

INFPHD205 Professional credits

Professional credit can be given for scientific public activities that help integration into academic life and the scientific professional community, for scientific activities that support scientific work (e.g. professional activities carried out in the organization of conferences/workshops, curriculum development, etc). Professional credits can also be given for supervising BSc or MSc theses.
The supervisor makes a proposal for the recognition of professional credit and the head of the relevant doctoral program approves it.

INFPHD300- Teaching credit

During the 8 semesters of the doctoral program, maximum 48 credits can be acquired out of teaching (24 credits in the training and aducational phase, 24 credits in the dissertational phase)

When counting teaching activities, 1 contact hour (45 minutes) corresponds to 2 credits. The educational activity is certified by the relevant head of department and the number of credits for it recognized by the supervisor and with the approval of the head of the relevant doctoral program.

Comprehensive (complex) exam

The list of subjects for the complex exam is compiled according to the doctoral programs.

At the end of the last semester before the complex exam, the doctoral student prepares a detailed research document (report), which is reviewed by his supervisor and the head of the relevant doctoral program. The minimum academic requirement for applying for the complex exam is a paper submitted for publication.. It is recommended that the publication be at least accepted for publication.

Mandatory chosen subjects of the complex exam in the doctoral program:

Subjects of the complex exam

- Databases, knowledge bases
- Information systems
- Design and analysis of algorithms
- Complexity theory
- Fourier analysis and its applications
- IT security
- Computer algebra
- Artificial Intelligence
- Numerical calculations
- Methodology of teaching IT
- Parallel and distributed systems
- Correctness and semantics of programs
- Programming methodology
- Programming languages
- Basics of computational theory
- Computer graphics
- Computer systems
- Information technology curriculum theory
- Spatial informatics
- Navigation technologies
- Remote sensing
- Spatial data visualization

Recommended subjects of the complex exam

- Data mining
- Data structures and algorithms
- Approximation theory
- Bioinformatics
- Numerical solution of differential equations
- Numerical solution of systems of equations
- Computational models and their applications
- Fractal geometry, chaos
- (mathematical) Modeling of curves and surfaces
- Information theory and coding
- Applications of information systems
- Image processing (Computer vision)
- Modern databases
- Mathematical logic
- Neural calculations
- Programming technology
- Temporal logics
- Mathematics of www and networks
- Spatial databases and data mining
- Map projections in GIS