The training plan of the József Hatvany Doctoral Council for Information Sciences

2025

The training area at the József Hatvany Doctoral School of Information Technology is necessary for the development and application of applied engineering sciences. It is related to the field of information technology. The Doctoral Council operates within the Faculty of Mechanical Engineering and Information Technology, where the field of information technology training is closely linked to mechanical and electrical engineering training. The Doctoral Council builds on the following master's programmes:

- Master's degree in Engineering Informatics;
- Master's degree in Electrical Engineering;
- Master's degree in Logistics Engineering.

As a result of this closer cooperation, the following areas of training play a key role in the doctoral school:

- **Applied computer** science,
- **Production Informatics**, **Measurement and Control Information** Systems**,**
- **Material flow systems and logistics** informatics

Complex exam theoretical subjects:

The examinee must take exams in at least two subjects. One of the subjects designated for the exam must belong to the foundation subjects, while the other must belong to the chosen topic area. The subjects that can be taken are listed in the Course List table.

Applied computer science topic area

The professional background of the **Applied Computer Science** topic area is provided by the Department of Analysis and the Department of Applied Mathematics of the Institute of Mathematics, as well as the Department of General Informatics of the Institute of Informatics. Head of the topic area: *Jenő Szigeti*, DSc, professor emeritus.

The aim of the topic area is to present and research some of the fundamentally important areas of application of computer science. The main areas are algorithm theory and its various applications, engineering calculation algorithms, data and knowledge bases, and parallel and distributed systems. Basic knowledge of engineering and technical informatics is required to master the subjects. The aim of the research related to the subjects and the topic area is to develop technical informatics. The topic area comprises four topic groups:

Algorithm theory and applications of discrete structures

The head of the topic group is *Jenő Szigeti*, DSc, professor emeritus. The aim of the topic group is to provide the computational science foundation necessary for the practice of computer science, as well as to provide a deeper introduction to the theory and applications of algorithms and to conduct research primarily in the areas of complexity theory, programming theory, databases and operating systems. The programme provides an opportunity to learn about the applications of computer algebraic and computer geometric algorithms, as well as information and code theory. The other subjects in the programme serve to lay the foundations and improve modelling skills.

Computer graphics and geometric modelling topic group

The head of the topic group is *Imre Juhász*, DSc, Dr. Habil., Professor Emeritus. The aim of the topic group is to provide a theoretical foundation for research in the fields of computer graphics and computer-aided geometric design (CAGD) and to present their applications. In the field of CAGD, the emphasis is on the modelling of curves and surfaces, while in the field of graphics, the emphasis is on computer game development. Of course, these are not exclusive areas, as the theoretical foundation and the related toolset also enable research in other areas of computer graphics and geometric modelling.

Data and knowledge bases, knowledge-intensive systems research group

Head of the research group: *László Kovács*, PhD, Dr. Habil., university professor. The Data and Knowledge Bases, Knowledge-Intensive Systems research group covers the areas of applied computer science, database management, artificial intelligence methods, and information management. It presents the theoretical background of the related interdisciplinary knowledge base as well as the most important areas of application. Through the analysis of the algorithms and methods presented, students gain a deeper insight into the advantages and efficiency of

each method and the related research directions. The topic group covers the basics of data mining methods, including both the theoretical background of the methods used and the technical and organisational conditions of their application. Within data mining technologies, the widely used topics of association, classification and clustering are given special attention. Within data mining tools, both classical statistical methods and neural network-based methods are part of the curriculum.

In addition to subjects providing a general overview, the topic group also includes several subjects that provide deeper and broader knowledge of specific areas. Within this framework, it is possible to gain a more detailed understanding of the mathematical background of individual algorithms and the related theoretical material of discrete mathematics (combinatorial optimisation, concept analysis). In addition, the topic group also covers knowledge representation, automatic reasoning procedures, and a deeper understanding of neural networks, fuzzy methods, and genetic algorithms (soft computing) within the framework of artificial intelligence. In addition to the above, modern, intelligent methods of database management are also presented, providing a deeper understanding of exact and approximate search techniques, the management of unstructured data systems, and deductive databases. Within the framework of this topic group, students will be able to master modern information management methods and procedures, develop algorithms for knowledge-intensive tasks, and review and effectively apply market products related to these areas.

Intelligent Computing Methods

The head of the topic group is *Szilveszter Kovács*, PhD, Dr. Habil., Associate Professor. The aim of the research group is to conduct research into modelling paradigms (fuzzy, neural and genetic methods and their extensions) in the field of intelligent computing methods (soft computing). In addition to basic methodological research, the research group's work also covers research into novel applications of basic methods. The research group's current work focuses on fuzzy rule interpolation methods, reinforcement learning-based fuzzy modelling, ethologically motivated human-machine interaction modelling, and eto-robotics. At the application level, the work of the research group is also linked to the research areas of the Data and Knowledge Bases, Knowledge-Intensive Systems research group.

Production informatics, measurement and control information systems

The professional background of this research area is provided by the Department of Applied Informatics of the Institute of Informatics, the Department of Automation and Infocommunications of the Institute of Electrical Engineering, and the Department of Electrical Engineering and Electronics. The head of this research area is *Gyula Kulcsár, PhD, associate professor*.

Production informatics is one of the applied fields of information technology that deals with the principles, models and computer applications used in the design and control of production systems and processes. The development of production informatics follows a bottom-up trend, which means that initially the goal was to solve computer control problems related to the automation of technological operations (e.g. CNC and PLC control technology, robotics), and only later did the various functional tasks of computer-aided engineering come to the fore. Today, production informatics covers the entire functional spectrum of technical design and control as well as production management, and the computerised integration of business and technical processes (Enterprise Resource Planning) has become an agenda item not only within the physical framework of a company (Computer Integrated Manufacturing paradigm), but also on an inter-company scale (Virtual Enterprise paradigm). Production informatics is increasingly using 3D body modelling, object-oriented modelling and artificial intelligence methods to solve analysis and synthesis tasks in technical design. In Hungary, the school of production informatics research associated with József Hatvany achieved internationally recognised results as early as the 1970s in areas such as Dialóg CNC, the control of uncertain and knowledge-deficient manufacturing systems, and other fields. Today, with computer-integrated manufacturing spreading rapidly and on a large scale in Hungarian industry thanks to investments by multinational companies, there is a growing demand for professionals skilled in the design and development of production informatics applications. It is important to highlight the need for research in the development of computer-aided design applications (CAD, CAPP, PPS), which is lagging behind in the field of software due to the rapid development of computer hardware, processors and networks. The success of the IMS (Intelligent Manufacturing Systems) project, initiated by Japanese researchers, demonstrates the growing importance of production informatics research. The Institute of Informatics at the University of Miskolc maintains good relations with researchers at MTA SZTAKI, which increases the research efficiency in this field. There are two research groups in this area.

Computer-integrated manufacturing informatics research group

The research group is led by *Gyula Kulcsár, PhD, associate professor*. One of the important research topics in production informatics is the functional development of technical design and control applications and the network integration of applications. A new organisational paradigm has also emerged in this field in the form of concurrent engineering. The integration of CAD-CAPP-PPS components not only promises to speed up design processes, but also enables a realistic and practical approach to multi-level optimisation problems. Increasing the flexibility of technological design, robust technological design, and intensity-controlled and group-principle-based computer-aided design have become important areas of research in production management. Significant research results have been achieved in these areas at the Department of Applied Informatics, which will enable further research. There is hope for significant improvements in the laboratory background of production informatics research in the near future. Several OTKA, FKFP and one NKFT (Széchenyi) projects provide a framework for ongoing research . The aim of the research is to develop design and control procedures that are ready for industrial application using distributed architecture. There is also a significant national economic interest in training young researchers who are strong in technical and IT thinking in this field.

Measurement and control technology information systems research group

The head of the research group is *László Czap*, PhD, university professor. The objectives of control engineering and telematics research topics: Continuous and intermittent technological control, as well as information processing and transmission, are an integral part of production informatics. Within this, the following topics are of particular importance: the theory of sampling control, the operating system of distributed process control systems, the examination of the real-time nature of client-server services, and the theoretical and practical aspects of process control reliability. We place great emphasis on the stability and convergence issues of intelligent control systems based on the application of artificial intelligence methods (fuzzy, neural, self-learning hybrid, etc.), as well as on the design and testing methods of real-time operation.

An integral part of the research group is the investigation of computer-aided control system design (CACSD), modelling and simulation methods based on the MATLAB software package and toolboxes. Of particular importance within the research group is research into the real-time

operation and transmission security of various industrial communication systems (field buses) and the improvement of these parameters, as well as the industrial applicability of smart grids. Research into human-machine interface methods for open process control systems (OPC) is also a key objective, with a particular focus on the control engineering applications of information and telecommunications. Within this, we place particular emphasis on industrial ETHERNET and WAP services and programming issues, and research into reliability, data protection and service issues based on the analysis of control technology-oriented telecommunications protocols. Another objective is research into computer-aided design (VHDL) and testing methods for digital systems, as well as image processing-based testing methods. The objectives of research topics in electronic systems and measurement technology: The subjects of this topic are related to the research project in the field of electronics and measurement technology.

Objectives of research topics in electronic systems and measurement technology: The subjects of this topic are related to the research project in the field of electronics and measurement technology. In the field of computer-aided and intelligent measurement technology, the primary objective is to develop new measurement procedures and methods for local, distributed intelligence and remote data measurement. In relation to measurements, the objective is to research new, fast and efficient signal processing methods, with particular emphasis on industrial measurement technology. In the field of electronic systems, computer-aided electronic design, research into fast and high-frequency simulation methods, and the modelling of electromagnetic fields from an EMC perspective are of particular importance in order to increase the reliability and interference immunity of IT and electronic systems.

Material flow systems and logistics informatics

The topic area of material flow systems and logistics informatics is managed by the Logistics Institute. The head of the topic area is *Béla Illés*, PhD, Dr. Habil., Professor Emeritus.

Material flow systems and logistics (material and equipment flow integrated with information and energy flow) is a rapidly developing, independent field of applied informatics, which uses applied mathematics and applied informatics to develop and solve models that more accurately describe the real-world conditions encountered in practice in networked, global systems and networked global systems. During the programme, students build on their university studies to gain a deeper understanding of discrete mathematics, stochastic processes, optimisation

procedures, information systems, artificial intelligence methods, operating systems, data structures, computer networks, data transmission systems, logistics systems and material flow systems, as well as the scientific fields of these production, service and network-based global systems, with an emphasis on the IT approach.

The PhD students enrolled in this topic area are graduates of the logistics block of the Technical Informatics programme at the Faculty of Mechanical Engineering of the University of Miskolc. There is consistently high interest in this training block from both students and the business community.

The courses offered provide an opportunity to examine large, complex systems, to perform optimisations that take into account multiple objective functions and diverse conditions and constraints, and to compare the operating and control strategies of different system variants.

The development of each topic requires the use of modern, technologically advanced data collection methods, simulation and heuristic methods in addition to exact procedures, and the representation of the virtual world. The final results of the research will include methods, algorithms and computer programmes. Within this topic area, we plan to cover the following key topics: material flow systems in manufacturing and service companies, procurement, distribution, production, service and recycling logistics systems, warehousing logistics systems, and networked global logistics.

Information system for the design and development of material handling systems

The head of the topic group is *Béla Illés* PhD, Dr. Habil. Professor Emeritus. The aim of the topic group is the joint management of the set of information related to the objects of material handling systems and the information related to the algorithms operating the objects. Designing optimally designed and functioning material flow systems by applying specific objective functions for given parameters. Exploring the effects of design-related parameters on the final objective, analysing the effects of individual parameters on the objective function and determining their weight.

Information system for the operation, management, control and monitoring of material flow systems

The leader of the research group is *Ágota Bányainé Tóth*, PhD, Dr. Habil., university professor. The aim of the research group is to explore the possibilities and methods of investigating

problems related to the operation, management, control and monitoring of complex stochastic logistics processes using simulations. Based on the results provided by the simulations, different management and control strategies are compared using various optimisation methods, and operational and management algorithms that are useful in practice are specified.

Training programme

In the training process of the Doctoral Council, the first task for all doctoral students is to acquire the theoretical foundations essential for research in their field.

The training structure of the Doctoral Council is two-tiered. The first level (basic science training) covers the basic mathematical and IT knowledge that is essential for the study of IT sciences and can be used in all topic areas related to the school. The second level (specialised training) serves to provide a theoretical foundation in the chosen topic area and topic group.

The compulsory selection of a group of subjects from a given selection of four subjects ***and*** the ***successful completion of the examination*** serve to acquire specialist knowledge in mathematical and IT modelling. The aim here is to acquire a more in-depth theoretical foundation than is usual at university level and to learn how to handle complex models with confidence. If justified by the chosen field of research, additional theoretical foundation subjects may be taken within the framework of the Elective Subjects block, or even beyond it. The main area of ***mathematical foundation*** is Discrete Mathematics. The main areas of ***theoretical IT foundation*** are Algorithm Theory and Programming Paradigms. The inclusion of one compulsory foundational subject from a given selection for each topic area and topic group, and the successful completion of the examination, serves to acquire theoretical knowledge of the chosen field of application (research). The aim here is to acquire a deeper and more comprehensive understanding of specialist concepts, relationships and laws than is usually provided by university education. The topic areas and topic groups generally prescribe a single summary subject here, but the professional structure of the School allows for their subsequent expansion in line with student needs.

The second task of the Doctoral Council (but by no means less important) is to ***carry out the chosen research work*** and achieve and publish new scientific results. This task can also be divided into two sub-tasks:

Taking at least two topic groups and passing the exams from the Elective and Foundational subject blocks. These subjects ***contain the specialised knowledge*** necessary for the research work outlined in the student's scientific research plan. It is also possible to take subjects announced by the István Sályi Doctoral Council of Mechanical Engineering Sciences. It is recommended that at least one of the subjects be devoted to gaining a deeper understanding of the theoretical background of applied information technologies. The School does not set stricter conditions here so as not to limit the student's independence in choosing a research topic. We see this as one of the guarantees of a more research-oriented transformation of doctoral training without compromising theoretical rigour.

Parallel to and following the above training task, students choose ***an independent research topic***, prepare a research plan, and carry out systematic and targeted research work, which yields results that are ready for publication and evaluation in the scientific community. This phase concludes with the formulation and successful defence of doctoral theses.

At the end of the fourth semester of the doctoral programme, as a conclusion to the training and research phase of the programme and as a prerequisite for the start of the research and dissertation phase, ***a complex examination must be passed***, which measures and evaluates academic and research progress.

A minimum of eight (8) subjects must be taken as part of the doctoral programme, which must be completed with a successful examination. The enrolment of the 8 subjects is governed by a set of rules. In addition to the 8 subjects, further subjects may be taken if justified by the subject area. The total number of subjects taken may not exceed 12. The purpose of the rules is to provide doctoral students with appropriate guidance on the reasonable composition and internal structure of the knowledge to be acquired during their doctoral studies, while also giving them sufficient freedom to compile the knowledge that best supports their chosen field of research.

The rules are as follows:

- Students must take four compulsory foundation courses, two of which are in mathematics and two in computer science.

- At least one (1) subject must be taken in each topic area as prescribed for that topic area (or from among the compulsory elective subjects). This subject summarises the most important theoretical foundations of the topic area.
- At least one (1) subject must be taken from each topic group as prescribed for that topic group (or from the compulsory elective subjects). This subject summarises the most important theoretical foundations of the topic group.
- Two (2) additional subjects may be freely chosen from among all subjects announced by the Doctoral Council of the Faculty.
- The course structure is therefore 4-2-2. Of course, there is no obstacle to taking more than the minimum number of subjects in each group. The school does not set an upper limit here, but leaves it to the doctoral supervisor to reasonably limit the number of subjects taken.
- During the training and research phase (first 4 semesters), a total of at least three public research seminars must be completed, one of which may be replaced by the scientific workshop discussion of the dissertation part of the comprehensive examination.

The recommended course structure is shown in the table below:

Place of the subject in the structure	**Semester**			
	1	2	3	4
Foundational A1.	+			
Foundational B1.	+			
Foundational A2		+		
Foundational B2.		+		
Topic area			+	
Topic group			+	
Optional				+
Optional				+

Doctoral students participating in organised doctoral training take the comprehensive examination at the end of the fourth semester, as the conclusion of the training and research phase of the programme and as a prerequisite for beginning the research and dissertation phase. Students applying for individual preparation must take the comprehensive examination as part of the admission process, before their doctoral student status is established.

Doctoral students who have earned the required 240 credit points in the doctoral programme receive an absolutorium. The absolutorium is a prerequisite for initiating the doctoral procedure.

The compulsory subject group for mathematics and computer science is as follows:

1. Discrete Mathematics 1
2. Algorithm Theory
3. Logic for Mathematics with Applications
4. Paradigms of Programming

The compulsory subjects (subject groups) in the school's three topic areas and topic groups are summarized below:

(1) Applied Computational Science topic area

Compulsory subjects in this topic area:

- Differential and Integral Equations
- Ontology-Based Information Models
- Parallel Algorithms
- Modern Analysis

(A) Data and knowledge bases, knowledge-intensive systems topic group

Compulsory subject of the topic group:

- Theory and Practice of Data-Mining

(B) Computational intelligence topic group

Compulsory subjects in this topic group:

- Computational Intelligence

(C) Computer graphics and geometric modelling topic group

Compulsory subjects in this topic group:

- Modelling of Curves and Surfaces

(2) Production Informatics, Measurement and Control Information Systems topic area

Compulsory subject in this topic area:

- Theory of Production Systems and Processes

(A) Informatics of computer integrated manufacturing topic group

Compulsory subject in this topic group:

- Modeling of Manufacturing Processes

(B) Measurement and control information systems topic group

Compulsory subject of the topic group:

- Control Engineering Information Systems

(3) Material Flow Systems, Information Technology of Logistics topic area

Compulsory subjects in this topic area:

- Theory of Material Flow Systems
- Theory of Logistics Systems

(A) Information systems for the design and development of material handling systems topic group

Compulsory subjects in this topic area:

- Procurement and Distribution Logistics
- Production Logistics

(B) Information system for the operation, management and controlling of material flow systems topic group

Compulsory subjects in this topic group:

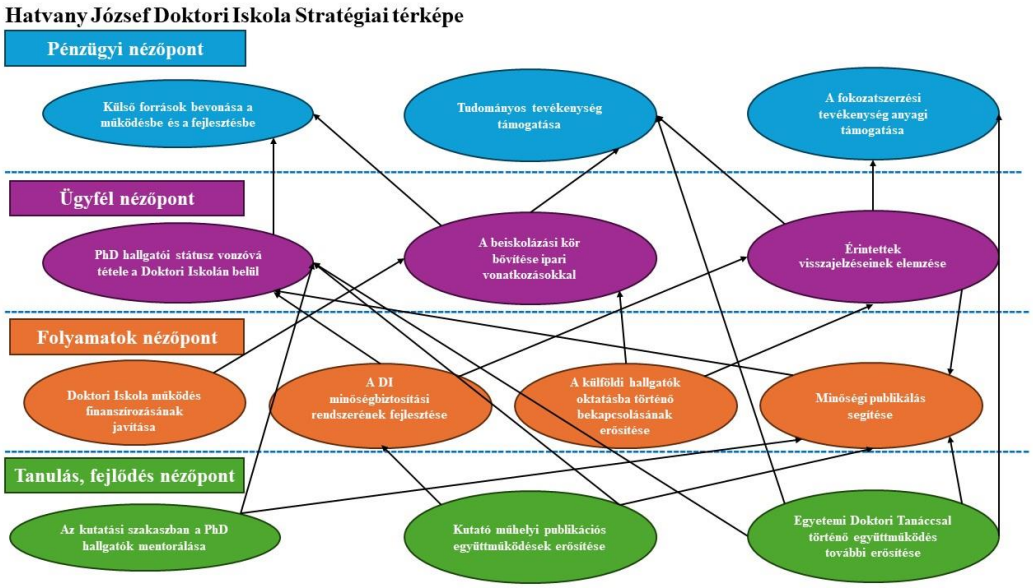
- Logistics of Manufacturing Systems
- Service Logistics

Training development plans, objectives, tasks and expected results for 2019-2024

One of the key components of the strategic map developed by the József Hatvany Doctoral School of Information Sciences (hereinafter referred to as HJDI) in 2024 is the Processes Perspective module. This module covers the following main topics:

- Development of the DI quality assurance system
- Involvement of foreign students in training, internationalisation,
- Quality publishing, research support.

These points can be implemented through several specific sub-points. HJDI's related training development plans aim to make the following sub-areas more efficient.



The credit system for doctoral training

The evaluation of prestigious publications played a key role in the development of the credit point system (Q1-rated journal article: 80, Q2: 60, Q3: 50 credit points). Following the training and research phase of the programme, doctoral students who have passed a complex examination, completed four semesters and earned at least 120 credits, including all academic credits, during the first four semesters may begin the research and dissertation phase. A

minimum of eight subjects must be taken as part of the doctoral programme, which must be completed with a successful examination. In addition to the eight subjects, further subjects may be taken if justified by the subject area. The total number of courses taken may not exceed 12. Thus, a maximum of 40-60 credits can be earned (5 credits per course). Courses advertised for doctoral students may be taken by students enrolled in master's programmes in parallel with their studies in their final academic year. Upon successful admission to the PhD programme, the credits earned by the student in the master's programme will be recognised at the same time as the admission decision.

In the case of individual preparation, after meeting the admission requirements and successfully completing the comprehensive examination, students can proceed directly to the second, research and dissertation phase of the programme. The conditions for application are the existence of scientific research results proven by publications and documented in the MTMT, and the achievement of at least 50% of the publication credits required from applicants at the end of the training and research phase. Based on the supportive opinion of the designated admissions committee, the comprehensive examination may be taken, and upon successful completion, the applicant will automatically receive 120 credit points.

The student's independent research on the dissertation topic is assessed on the basis of a written and professionally reviewed paper submitted to the doctoral school and the related research seminar, as well as the research work supervised by the student's supervisor in the "Research Project" course, the student may receive a maximum of 15 credit points per semester during the training and research phase and a maximum of 20 credit points per semester during the research and dissertation phase. A maximum of 5 credits per semester may be awarded for consultations on the "Research Project" subject from the credits available for independent research on the dissertation topic.

A maximum of 5 credits per semester may be awarded for research abroad within the framework of a short mobility programme (5-60 days), upon presentation of a report and its acceptance by the supervisor(s).

A maximum of 5 credits per semester may be awarded for research work carried out within the framework of research cooperation related to departmental research, upon presentation of a report and its acceptance by the supervisor(s). A maximum of 5 credits per semester may be awarded for teaching activities (1 credit per hour per semester). To obtain a certificate of

completion, students must earn 240 credits as follows: courses (40-60 credits), publications related to the research topic (at least 50 credits), active participation in a research project (at least 20 credits), participation in teaching (up to 20 credits), conference presentations (at least 20 credits).

Credit points

Achievements in the programme are recognised on the basis of a credit system. The following credit points can be awarded for each activity completed.

Main activity	Sub-activity (if any)	Credit points
Completion of compulsory subjects (A) (4 subjects)		5
Completion of elective subjects (min. 2)		5
Completion of optional subjects (min. 2)		5
Research seminar for one semester during the training phase		0-10
Research seminar for one semester during the research phase		0-20
Research work related to the dissertation for one semester (only acceptable in semesters 1-4)		0-10
Research work related to the dissertation for one semester (only acceptable in semesters 5-8)		0-15
Complex exam		0
Teaching activity for one semester		0-5
Short mobility programme for one semester		0-5
Second language exam		15-25
Publication	In a Q1-rated journal	80
	In a Q2-rated journal	60
	In Q3-rated journals	50
	Other indexed, prestigious international journals	30
	In other peer-reviewed journals	20
	Foreign language article published at an international conference	15
	Presentation at an international conference	15
	Article published at a Hungarian domestic conference	10
	Presentation at a Hungarian domestic conference	10
	Teaching aid	1-4
	Review in a foreign language	4
	Review in a foreign publication in a foreign language	5
	Patent submitted	5

Main activity	Sub-activity (if any)	Credit points
	Domestic patent granted	20
	Foreign patents granted	40

Complex examination

At the end of the fourth semester of doctoral training, as a conclusion to the training and research phase and as a prerequisite for beginning the research and dissertation phase, doctoral candidates must pass a comprehensive examination in public before a committee. The condition for admission to the comprehensive examination is the acquisition of at least 90 credits, including all study credits, during the "training and research phase" of the doctoral programme.

No credit points are awarded for passing the comprehensive examination.

The comprehensive examination consists of a theoretical and a dissertation part. The examination committee and the minimum of two and maximum of three subjects/topics for the theoretical part are appointed by the Doctoral Council at the end of the third semester, taking into account the supervisor's proposal. If the second foreign language required for the degree is demonstrated by completing one of the subjects of the comprehensive examination in the second foreign language, the examination of the subject in question shall also be conducted in that language. In the dissertation part of the comprehensive examination, the doctoral student gives an account of their knowledge of the literature, reports on their research results, presents their research plan for the second stage of the doctoral programme, and outlines the schedule for the preparation of the dissertation and the publication of the results.

List of courses

Courses offered by the Doctoral Council

Course code	Course name	Type
I. Fundamentals of Mathematics and Computer Science		
GEIAL401-a	Paradigms of Programming	**Compulsory**
GEMAK416-a	Theory of Algorithms	

Course code		Course name	Type
	GEMAN401-a	Discrete Mathematics 1	
	GEMAN421-a	Logic for Mathematics with Applications	
	GEMAN402-a	Modern Analysis	Optional
	GEMAN403-a	Discrete Mathematics 2	

Course code		Course name	Type
II. Applied Computational Science (topic area)			
	GEMAN411-a	Differential and Integral Equations	**Elective**
	GEIAL424-a	Ontology-Based Information Models	
	GEMAK409-a	Parallel Algorithms	
	GEMAN402-a	Modern Analysis	
	GEFIT412-a	Computer Simulation of Deterministic Physical Processes	Optional
	GEFIT413-a	Computer Simulation of Chaotic Physical Processes	
	GEFIT421-a	Understanding the Physics of the Hardware	
	GEIAK433-a	Knowledge Storing and Reasoning Methods in Expert Systems	
	GEIAL402-a	Distributed Algorithms	
	GEIAL407-a	Parallel and Distributed Systems	
	GEIAL427-a	Graph Neural Networks with Applications	
	GEIAL456-a	Fuzzy Systems	
	GEIAL482-a	Software Defined Networking	
	GEIAL483-a	Nature-Inspired Optimization Algoritms	
	GEMAK411-a	Numerical Methods I.	
	GEMAK412-a	Numerical Methods II.	
	GEMAK413-a	Methods of Optimization	

Course code	Course name	Type
GEMAK414-a	Stochastic Methods	
GEMAK417-a	Modelling of Internet with Random Graphs	
GEMAK418-a	Dominant Sets of Graphs and their Applications	
GEMAK419-a	GOA Sets of Graphs and their Technical Applications	
GEMAK420-a	NP-complete Problems in Graph Theory	
GEMAK421-a	Proofs in the Graph Theory with Computer	
GEMAN422-a	Lattices, Concept Lattices and Fuzzy Methods	
GEMET401-a	Continuum Mechanics	
GEMET406-a	Boundary Element Method	
GEMET407-a	Finite Element Method	
Data and knowledge bases, knowledge-intensive systems (topic group)		
GEIAL417-a	Theory and Practice of Data-Mining	**Compulsory**
Computational intelligence (topic group)		
GEIAK432-a	Computational Intelligence	**Compulsory**
Computer graphics and geometric modelling (topic group)		
GEAGT401-a	Modelling of Curves and Surfaces	**Compulsory**

Course code	Course name	Type
III. Production Informatics, Measurement and Control Information Systems (topic area)		
GEIAK401-a	Theory of Production Systems and Processes	**Compulsory**
GEVAU402-a	Advanced and Intelligent Control Systems	
GEVAU404-a	Speech Information Systems	
GEVAU413-a	System on Chip Design and Modelling Methods	
GEVAU415	Telecommunication in Control Engineering	
GEVAU460	Embedded Systems and Architecture	
GEVEE405-a	Electronic Systems and Metrology	

Course code	Course name	Type
GEVEE412-a	Computerized Measuring Systems	
GEVEE413-a	Computer Aided Electronic Design	
Informatics of computer integrated manufacturing (topic group)		
GEIAK403-a	Modeling of Manufacturing Processes	**Compulsory**
Measurement and control information systems (topic group)		
GEVAU401-a	Control Engineering Information Systems	**Compulsory**

Course code	Course name	Type
IV. Material Flow Systems, Information Technology of Logistics (topic area)		
GEALT408-a	Theory of Material Flow Systems	**Compulsory**
GEALT410-a	Theory of Logistics Systems	
GEALT411-a	Information Technology of Logistics	Optional
GEALT416-a	Logistics of Quality Assurance, Product Logistics	
GEALT417-a	Recycling Logistics	
GEALT418-a	Global Logistics	
GEALT419-a	Storage Systems	
GEALT420-a	Mathematical Models of Logistics	
GEALT422-a	Simulation of Material Flow and Logistics	
GEALT423-a	Transportation-Forwarding	
Information system for planning and designing material handling systems (topic group)		
GEALT412-a	Procurement and Distribution Logistics	**Compulsory**
GEALT413-a	Production Logistics	
Information system for the operation, management and controlling of material flow systems (topic group)		
GEALT414-a	Logistics of Manufacturing Systems	**Compulsory**

	Course code	Course name	Type
	GEALT415-a	Service Logistics	

	Course code	Course name	Type
V. Other Optional Courses			
	GEVGT469-a	Modern Search of the Literature and Publication	Optional
	GEVGT470-a	Research Methodology for Technicians	
	MAKDHN1EN	Art of Doing Science	