BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS

Doctoral School of Physics

Education Plan

Contents:

COMPONENTS OF THE PHD PROGRAMME

The most important component of the doctoral programme is the independent research activity completed in the research topics announced by the Doctoral School. Each doctoral student is assigned one and only one supervisor, who have full responsibility in guiding and helping the academic and research work of the doctoral student working on the topic, and also the publication of results and the completion of the doctoral theses. The dual supervisory system is only allowed – and then requires the involvement of a co-supervisor – in the case of international co-operations, or in the case of interdisciplinary topics, if the topic was approved by the Council of the Doctoral School (DIT) and the topic announcement was made on the prior consent from the University Habilitation Committee and Doctoral Council (EHBDT). On a contractual basis established with the Doctoral School, if the supervisor is external to the University, the Council of the Doctoral School (DIT) assigns an internal consultant to support the supervisor's work and to monitor the professional progress of the student.

Throughout the doctoral programme, additionally to the doctoral **subjects** announced for the particular semester, the students may select MSc or PhD subjects – even from the curriculum of an other university – that are accepted and credited by the Council of the Doctoral School. The curriculum is further extended by the lectures held in English by lecturers invited for particular semesters, and the mutual cross-learning agreement with Eötvös Lóránd University. Credits acquired for attending subjects are grouped for the first 4 semesters of the two-staged programme. International activities during the last 4 semesters and related skill developments are recognized with the curriculum credit points granted for attending international intensive courses, "**summer schools".**

Teaching under guidance shall form a part of the training, where students can improve their communication and presentation skills under the guidance of a designated lecturer. The subject and related credits are set by the head of the supervisor's or the consultant's department – with the agreement of the supervisor. The completion of the subject is certified by the head of department based on the opinion of the designated lecturer.

The tutorial character of the education is emphasized by the regular **consultations** where participation is recognized by credit points, and the support of research and publication activities. The competence of students and their activities at consultation are assessed by the supervisor in each semester.

In the second stage of the programme, the emphasis shifts toward the research work, publication of results and the completion of the thesis. Research credits recognize the **publication** of results in international journals, or the presentation at international **conferences** (lecture or poster), as well as the study visits or research work completed in international co-operation at a foreign partner.

By giving credits for publication activities, the supervisor proves that by acquiring all publication credit points before the end of the fourth semester, the student meets the precondition to be admitted to the comprehensive examination, and similarly, by the end of the eight semester, the minimum requirement of acquiring a degree is met. Research credits can be conferred on condition that the results achieved during the reporting period have been presented in a lecture form delivered on a PhD presentation day.

MODEL CURRICULUM

Subject/type	**Total credits**	1. semester	2. semester	3. semester	4. semester	5. semester	6. semester	7. semester	8. semester
Curriculum material	**24**								
Subject / KV	18	4/v/6	4/v/6	2/v/3	2/v/3				
Summer school /V	6						3		3
Teaching under guidance	**18**								
Teaching /K	18	2/f/3	2/f/3	2/f/3	2/f/3	2/f/3	2/f/3		
Research	**144**								
Consultation /K	48	6/f/6	6/f/6	6/f/6	6/f/6	6/f/6	6/f/6	6/f/6	6/f/6
Research work	96	12	12	12	12	12	12	12	12
Publication	**54**								
Publication /K	48	3	3	6	6	6	6	9	9
Conferences /V	6					3		3	
Total:	***240***	***30***	***30***	***30***	***30***	***30***	***30***	***30***	***30***

Students are requested to earn 240 credits. Credit limits for the various activities:

Curriculum material	18–30 credits
Teaching under guidance	18–24 credits
Research work	120–150 credits
Publication	54–66 credits

COMPREHENSIVE EXAMINATION

The Council of the Doctoral School shall decide on the admittance to the comprehensive examination. Students are only allowed to take the exam if they earn at least 90 credits during the first four semesters, and all **subject credits** prescribed in the model curriculum of the doctoral school (except for students preparing individually for acquiring the doctoral degree, whose legal relationship with the university will be established by the registration for and admittance to the comprehensive examination).

The publication related condition for admittance to exam is the publication - or accepted or submitted for publication – of at least **one** scientific publication in a "Web of Science" qualified journal, or a scientific publication electronically published in arXiv (lanl.gov), furthermore, the verification of at least **one** lecture or poster presented at a conference. Formal compliance with this requirement does not automatically guarantee admittance to exam; the DIT substantially verifies the level of publication of scientific results, and also the candidate's contribution to the published results.

In the case of students preparing individually, the precondition for being admitted to the exam is formal compliance with the publication and language requirements of acquiring the doctoral degree (no thesis points are required at the time of registration, therefore, instead of the substantial evaluation, only expected numerical indicators have to be met).

Comprehensive exam has to be taken in public, before the Committee. The examination committee consists of at least three members, and minimum of one third of the members shall have no employment relationship with the institution operating the Doctoral School. The chair of the examination committee is a university professor, *or a* Professor Emeritus, *or* a lecturer, researcher with Doctor of the MTA title. Each member of the examination committee should have scientific degree. The supervisor of the examinee cannot be a member of the Committee. The supervisor shall deliver the supervisory assessment of the student's performance to the chair of the committee in electronic form at least one week before the set date of the exam. The supervisor shall be invited to the comprehensive examination.

The comprehensive examination is divided into two parts: one part assesses the theoretical competence of the student ("theoretical part"), whereas in the "thesis part" the examinees can prove their scientific progress.

During the theoretical part, the examinee takes exam in two subjects. The list of subject is included with the curriculum of the doctoral school, and is accessible on the webpage of the doctoral school. In the theoretical part of the exam, the doctoral students demonstrate their awareness of literature in the specific branch of science, and their current knowledge in theory and methodology.

In the other part of the comprehensive exam, the examinees provide an account of their awareness of literature in their research topic (in a presentation form), report their research results, present the research schedule for the second part of the doctoral programme, as well as the schedule of the thesis preparation and the publication of results. The presentation will also review the scientific importance and innovation value of the results, and - where applicable – the technology motivation behind the research, and practical applicability of the results. At least one week before the exam, the examinee submit a brief summary of results achieved to date to the committee, together with the papers published or sent for publication. Each member of the examination committee shall assess the theoretical and thesis part one-by-one, separate. The comprehensive exam will be qualified successful, if the simple majority of the committee members decide so regarding both parts of the exam. The doctoral student may retake a failed comprehensive exam on one occasion, within the same exam period.

Minutes including textual assessment shall be drawn up on the comprehensive examination. The outcome of the exam shall be announced on the exam day. The result of the comprehensive exam does not count in the qualification of the doctoral degree, but the successful completion is a precondition of being admitted into the second stage of the programme.

RESEARCH AREAS

SOLID STATE PHYSICS
Responsible: László Szunyogh

- **Spin Dynamics**
- **Magneto-Optical Spectroscopy**
- **Unconventional Density Waves**
- **Topological Insulators and Graphene**
- **Non-Equilibrium Thermodynamics**
- **Fractional Quantum Hall Effect**
- **Ab initio Electronic Structure Calculations**

NANOPHYSICS
Responsible: András Halbritter

- **Nanomagnetism**
- **Investigation of Atomic Size Nanostructures**
- **Quantumelectronics**
- **Molecular Quantum Systems**

PHYSICS OF QUANTUM SYSTEMS
Responsible: Gergely Zaránd

- **Quantum Field Theory**
- **Multifractal States in Disordered Systems**
- **Quantum Information Theory**
- **Applications of Quantum Electrodynamics**

STATISTICAL PHYSICS
Responsible: János Török

- **Physics of Granular Materials**
- **Modelling of Complex Systems**
- **Big Data Analytics**
- **Quantum Statistical Systems**

OPTICS
Responsible: Pál Koppa

- **Researching complex optical systems**
- **Laser Physics**
- **Photonics Devices**
- **Coherent Optical Metrology**

MATERIALS SCIENCE
Responsible: Gábor Kiss

Surface Physics and Surface Analysis
Development of Measuring Instruments for Materials Testing
Computational Materials Science

NUCLEAR TECHNIQUES
Responsible: Szabolcs Czifrus

Reactor Physics
Thermohydraulics and Related Researches
Nuclear Measurement Techniques and Radiochemistry
Fusion Plasma Physics and Applications

MEDICAL PHYSICS
Responsible: Dávid Légrády

Medical Imaging by Ionizing Radiations
Medical Imaging by Non-Ionizing Radiations
Radiotherapy
Radiation protection and radiation biology in medical physics

SUBJECT GROUPS

Solid State Physics subject group

Modern Solid State Physics (2/2/0/v/5)
Theory of Magnetism I (2/0/0/v/3)
Theory of Magnetism II (2/0/0/v/3)
Interacting Spin Systems in Real Materials (2/0/0/3)
Many-Body Physics I (2/0/0/v/3)
Many-Body Physics II (2/0/0/v/3)
Group Theory in Solid State Research (2/0/0/v/3)
Introduction into Superconductivity Theory (2/0/0/v/3)
Localization Theory (2/0/0/v/3)
Semiconductor Physics (2/0/0/3)
Magnetic Resonance (2/0/0/v/3)
Magnetic Resonance 2 (2/0/0/v/3)
Optical Spectroscopy (2/0/0/v/3)
Electronic Structure of Solid Matter I (2/0/0/v/3)
Electronic Structure of Solid Matter II (2/0/0/v/3)

Nanophysics subject group

New Experiments in Nanophysics (2/0/0/v/3)
Physics of Mesoscopic Systems (2/0/0/v/3)
Transport in Complex Nanostructures (2/0/0/3)
The Physics of One-Dimensional Systems (2/0/0/v/3)
Nanomagnetism (2/0/0/v/3)

Physics of Quantum Systems subject group

Random Matrix Theory and Its Physical Applications (2/0/0/v/3)
Wavelets, Coherent States and Multiresolution Analysis (2/0/0/v/3)
Foundations of Density Functional Theory (2/0/0/v/3)
Variational Principles in Physics (2/0/0/v/3)
The Path Integral Method in Physics (2/0/0/v/3)
Selected Topics from Quantum Mechanics (2/0/0/v/3)
Quantum Entanglement (2/0/0/v/3)
Coherent Controll of Quantum Systems (2/0/0/v/3)
Field Theory at Finite Temperature and in Non-Equilibrium (2/0/0/v/3)
Introduction to Theoretical Plasma Physics (2/0/0/v/3)
Magnetohidrodynamics in Low Dimensional Systems (2/0/0/v/3)

Statistical Physics subject group

Scaling and Criticality (2/0/0/v/3)
Phase Transitions (2/0/0/v/3)
Non-Equilibrium Statistical Physics (2/0/0/v/3)
Statistical Field Theory (2/0/0/v/3)
Dynamical Systems (2/0/0/v/2)
Transport Processes (2/0/0/v/2)
Evolutionary Game Theory (2/0/0/v/3)
Complex Networks (2/0/0/v/3)

Optics subject group

Physical Optics (4/0/0/v/5)
Laser Physics (2/0/0/v/3)
Optoelectronic Devices (2/0/0/v/3)
Holography and Applications (2/0/0/v/3)
Optical Materials and Technologies 1 (2/0/0/v/3)
Optical Materials and Technologies 2 (2/0/0/v/3)
Optical information Processing and Data Storage (2/0/0/v/3)
Optical Metrology (2/0/0/v/3)
Fundamentals of Optical Design (2/2/0/v/4)
Quantumelectronics (3/0/0/v/4)
Basic Physics of Optical Communication
Light Sources (2/0/0/v/3)
Introduction to the Physics of Ultrafast Pulses (2/0/0/f/2)
From Femtosecond Lasers to Attophysics (2/0/0/v/2)
ELI Preparatory Laboratory (0/0/4/f/2)
Design and Construction of Laser Systems (2/0/0/f/2)
Infrared and Raman Spectroscopy (2/2/0/v/3) (2/0/2/v/3)

Materials Science subject group

Electron- and Ionoptics (2/0/0/v/3)
Electrical and Optical Properties of Solids (2/0/0/v/3)
Vacuum Physics and Technology (2/0/0/v/3)
Experimental Methods in Material Science I (3/0/2/f/5)
Experimental Methods in Material Science II (3/0/2/f/5)
Introduction to Surface Physics (2/0/0/f/2)
Surface Physics and Thin Films I (4/0/0/v/3) (2/0/0/v/3)
Surface Physics and Thin Films II (4/0/0/v/3) (2/0/0/v/3)
Fundaments and Applications of Materials Science (2/0/0/v/2)
Physical Materials Science (2/0/0/f/3)
Microtechnology and Nanotechnology (2/0/0/f/2)
Trends in Materials Science (1/0/0/v/2)
Crystalline and Amorphous Material (2/0/0/v/3)
Spectroscopy and Structure of Matter (2/0/0/v/3)

Nuclear Techniques subject group

Nuclear Non-Proliferation (2/0/0/v/2)
Low Temperature Plasma Physics (2/0/0/v/2)
Nuclear Power Plants (3/1/0/v/5)
Material Testing in Nuclear Power Plants (2/0/0/v/2)
Chemistry of Nuclear Power Plants (2/1/0/v/3)
NPP incidents' analysis (3/2/0/v/6)
Nuclear Power Plant Operation (3/1/0/v/3)
Introduction to Fusion Plasma Physics (2/0/0/v/2)
CFD Methods and Applications (2/1/0/f/3)
Chapters of High Temperature Plasma Physics (2/0/0/v/3)
Sustainable Development and Energetics (2/0/0/f/3)
Large Fusion Devices (2/0/0/v/3)
Fusion Plasma Physics Laboratory Exercises (0/0/4/f/4)
Nuclear Physics (3/0/0/v/4)
Monte Carlo Particle Transport Methods (2/0/0/v/2)
Neutron and Gamma Transport Methods (2/2/0/v/5)

Nuclear Electrodynamics (2/0/0/v/2)
Nuclear Fuel Cycle (3/0/0/v/3)
Dispersion of Radioactive Matter in Environmental and Biological Systems (2/2/0/v/4)
Safety of Radioactive Wastes (3/0/1/v/4)
Radioanalytics (3/0/2/v/5)
Calculations in Reactor Physics (3/1/0/v/4)
Control and Instrumentation of Reactors (2/1/0/v/3)
X-Ray and Gamma Spectrometry (2/0/0/v/2)
Radiation Protection 2 (2/0/2/v/4)
Simulation Techniques (2/0/1/f/4)
Collisional Transport in Magnetized Plasmas (1/2/0/f/4)
Selected Topics in Nuclear Physics (2/0/0/v/2)

Medical Physics subject group

Radiobiology (2/1/0/v/3)
Physical Basis of Radiotherapy (2/0/2/v/4)
Radiotherapy II (2/0/0/v/2)
Brachytherapy (2/0/0/v/2)
Quality Assurance and Legislation (2/0/1/v/3)
Radiation Protection in Medical Physics (3/0/1/v/4)
Magnetic Resonance and Clinical Applications (2/1/0/v/3)
Monte Carlo Methods (2/0/2/v/4)
Neutron and Gamma Transport Methods (2/2/0/v/4)
Nuclear Medicine (2/0/1/v/3)
Medical imaging (3/1/0/v/4)
Physical Basis of X-Ray Diagnostics (2/0/0/v/3)
Ultrasound Diagnostics (2/0/0/v/2)
Dosimetry in Radiation Therapy (2/0/0/v/2)