Faculty of Engineering

Ph.D. Programme in ADVANCED-SYSTEMS ENGINEERING

Website: PhD in Advanced-Systems Engineering / Free University of Bozen-Bolzano (unibz.it)

Duration: 3 years

Academic year: 2024/2025

Start date: 01/11/2024

Official programme language: English

Programme contents

This international PhD program trains a new generation of researchers focusing on mechanical and industrial systems, automation, and electronic and information systems to carry out independent research in the areas of Advanced-Systems Engineering and to give them the opportunity to transfer and exchange knowledge with national and international research centers and industries.

The three-year PhD programme focuses on the study and development of advanced and intelligent systems through an interdisciplinary approach that responds to recent technological developments (e.g. Cyber-Physical-Systems, Industry 4.0, Internet of Things) by integrating the disciplines of mechanical engineering, manufacturing engineering, computer engineering and computer science. They are supported by specific skills in mathematics and artificial intelligence.

Ph.D. student projects cover the following research areas, which are actively pursued by research groups at unibz on a long-term basis, and considered in the Ph.D. in Advanced-Systems Engineering:

Mechanical and Industrial Systems Engineering
- Mechanical and mechatronic systems
- Advanced manufacturing technologies
- Mechanical engineering design and optimization
- Production and management systems,
- Smart Factory

Automation and Electronic Systems Engineering
- Autonomous systems
- Human-in-the-loop systems
- Thin-film devices and sensors
- Flexible and wearable electronics, smart textiles
- Micro and nano technology
- Soft and biocompatible sensor systems
- Robotic systems
- Automatic control
- Intelligent sensor/actor networks

Computer Systems Engineering
- Development and maintenance of intelligent software systems
- Distributed Systems and Security

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- Self-adaptive software systems
- Development and Operation of IoT Systems
- Quantum mechanics
- Dynamics on networks

The main features of the PhD are an interdisciplinary scientific approach and the participation of internationally renowned scientists in the Scientific Committee.

In addition, students will have the opportunity to further improve their ability to communicate ideas and results clearly and effectively in oral and written form, as well as to work in research groups. The final thesis must be written in English and must include translations of its abstract in both German and Italian. Ph.D. students can benefit from the special multilingual opportunities offered by the University, which include activities/events in English, Italian, German or other languages (seminars, elective courses, social events, etc.). The Ph.D. program will include lectures and research activities that will take place at unibz, accompanied with experiences that may be carried out at other universities, in Italy and abroad. Each Ph.D. student must spend at least 3 months (and up to a maximum of 12 months) abroad carrying out part of his/her research activities.

The Ph.D. programme is based on the following activities:

- Student must develop and organize a research plan and conduct a thorough literature survey that includes a synthesis and state-of-the-art analysis of the research topic. The literature survey must be completed within the first 6 months of the course and must be carried out under the guidance of and in consultation with one's supervisor and any co-supervisors. After six months at the latest, students must present and defend their research plan in front of the Ph.D Committee.
- Students must present the results of their research at one or more international conferences in the form of a paper or poster presentation. The results must be available and published in the accompanying conference proceedings.
- Students will have to spend at least three months abroad to carry out research activities.
- Students will have to attend compulsory courses focused on analysing and writing of scientific articles, as well as other courses, workshops or summer schools that will expand their background and deepen their expertise on topics related to their PhD thesis. These additional courses must be approved by the Ph.D. Committee. Student must pass all the relevant exams to obtain credits.

To be admitted to the final thesis exam, students must have published at least one article in an international, indexed and peer-reviewed journal, e.g. Scopus, as lead author. Exceptions to this rule will be evaluated and, if appropriate, approved by the Ph.D. Committee.

Please note that the program is full-time only and for its duration students are expected to devote their efforts to the completing of their PhD project.

Ph.D. phases

The Ph.D. research activities are divided into five phases, which will be completed in months 2, 6, 12, 24 and 36 of the programme. At the end of each phase, each student will have to present his/her activity, project, and results in front of an internal Committee composed of the supervisor and two members, at least one of whom from the Faculty of Engineering. Based on the internal Committee's assessment, the Ph.D. Committee will examine and evaluate each student's work and make recommendations if necessary.

Phase 1 **(first 2 months):** The Ph.D. Committee meets the students and assigns each student a supervisor. Together with the supervisor and possible co-supervisors, the student identifies his/her research topic (within the areas listed in this notice) and develops a study plan. The latter must then be approved by the Ph.D. Committee. Students may start attending courses relevant to their individual study plans.

Phase 2 (2nd-6th month): After an exhaustive literature review related to his/her research topic, as well as having completed the first steps in the research activity, each student will have to:
- prepare his/her own research programme;
- complete and/or attend courses relevant to his/her individual study plan;
- write a report on the state-of-the-art of his/her research topic;
- submit the research programme and the state-of-the-art report to the internal Committee for review.

Phase 3 (6th -12th month): Each student continues to carry out research activities on his/her own topic. He/she also attends courses, summer schools, seminars, or conferences. At the end of the phase, each student must:
- Present the research programme he/she intends to conduct abroad;
- Propose to the Ph.D. Committee a co-supervisor at the foreign university or research centre;
- Draw up a report on the first year's activity;
- Submit the research programme and state-of-the-art report to the international Committee for review.

Phase 4 (12th -24th month): Each student continues his/her research and finishes any courses that have been started. At this stage, it is likely that part of this time will be spent abroad.
At the end of the phase, each student must:
- Write a report on the first year's activity;
- Submit the research programme and the state-of-the-art report to the internal Committee for review.

Phase 5 (24th-36th month): Each student must finish: his/her research; the planned and required activity abroad, if required; write and submit manuscript(s) for publication in international peer-reviewed journal(s); complete his/her thesis (draft).

In order to be admitted to the final exam, each student must submit a report on the activity of the third year and the final thesis to the internal Committee. On the basis of the evaluation of the internal Committee, the Ph.D. Committee will assess the admission to the final exam.

During phases 4 and 5, students are also expected to attend international conferences to present the results of the activities developed within the Ph.D. programme, and to begin the preparation of the manuscript(s) for publication in peer-reviewed journals.

A list of potential research topics and faculty supervisors to be funded by unibz general scholarship is given in the table below.

Proposed Research Topics

Project Title	Supervisor
Smart definition of sources of inspiration for conceptual design based on neurophysiologic and biometric measures	Borgianni
Human-product interaction with sustainable products and sustainability-related cues or Areas of Interest	Borgianni
Electro absorption spectroscopy of energy-levels line up in organic electronics: optimization of charge injection and extraction	Cacialli
Bio-compatible and bio-resorbable photonics and optoelectronics	Cacialli
Engineering Biomaterials for 3D Bioprinting and Biohybrid Interfaces	Ciocca
Characterization of Advanced Engineering Materials: Finite Element Analysis and Experiments	Concli

Tribology and Fatigue of Mechanical Components: testing, modelling and simulations	Concli
Extended Reality (XR) to support operator training in industry	Dallasega
Development of smart, modular and movable manufacturing assets for viable and sustainable Manufacturing-as-a-Service	Dallasega
Computational methods for trajectory generation	Frego
Optimization methods for robotics	Frego
Methodologies for adaptable human-machine interaction in manufacturing	Gualtieri
Assistance systems for the social inclusion of vulnerable workers in manufacturing	Gualtieri
Sculpturing in Mixed Reality using Head Mounted Displays like the Apple Vision Pro	Haller/Russo
Smart Fibers for next-generation wearables	Haller
Machine learning for three-dimensional wood cutting optimization in sawmills	Hosseini
Model predictive control for quality-driven wood cutting optimization	Hosseini
Numerical simulations of coherent systems in quantum mechanics and quantum optics [Further keywords: Dicke effect, super radiance, quantum synchronization, plasmonic Dicke effect, Python QuTiP package]	Modanese
Qubits and quantum circuits: numerical simulations in Python and possible applications to electronics [Further keywords: Josephson junctions, Python QuTiP and QuCAT packages, quantum Monte Carlo	Modanese
Thin-film electronics based on unconventional electronic materials	Münzenrieder
Flexible transistors and circuits for wearable sensor systems	Münzenrieder
AI engineering for distributed dependable software systems	Pahl
Intelligent resource management for IoT edge and cloud computing	Pahl
Exploiting context and generative AI technologies for enhancing human-robot collaboration	Peer
Brain and body computer interface-controlled systems and robots	Peer
Neuromorphic devices based on printed organic materials	Petti
Plant wearables based on flexible and sustainable sensors	Petti
AI technologies for enhancing the interaction with musical cultural heritage	Pretto
New interfaces for the Internet of Sound	Pretto
Software security of AI-generated software. Studying the security of software that has been automatically generated by AI. Developing secure AI-generated software	Russo
Responsible software. Investigating and Improving software systems in terms of fairness, performance and security	Russo
Dynamic task and motion planning strategies for safe and ergonomic human robot collaboration in manufacturing	Vidoni
Multibody-based digital twin solutions for condition monitoring/vibration control	Vidoni
Time-delay control for persistent robotic systems	von Ellenrieder
Agile control and design of aerial forest firefighting vehicles	von Ellenrieder

* This is only a partial list of available projects, other topics related to the research activity of the members of the Ph.D. Committee may be studied.

Admission Requirements - Evaluation criteria for examinations/qualifications
Degrees from the former Italian university system: all
Master's degrees of the new system (laurea specialistica/magistrale): all

Foreign degrees
Similarly, candidates who have obtained a foreign degree must have a university level education (or equivalent) of at least five years and fulfil the prerequisites listed below:

Other:
The requirements for admission to the Ph.D. programmes are related to an appropriate educational and/or scientific and/or working background in the research fields of the Ph.D. research programme.

Degrees in <u>engineering</u> and <u>computer science</u> will be preferred.

The assessment of candidates for admission will always be carried out by means of:
 – Evaluation of the curriculum and academic qualifications;
 – Evalutation of the letter of motivation explaining the student's motivation for applying to this Ph.D. programme;
 – A personal oral interview.

During the interview, the knowledge of the English language will be verified.

The candidates' profile will be assessed on the basis of quality and potential synergy with the research areas of the Ph.D. Programme.

To apply for the Ph.D. Programme, applicants shall submit the following documents:
 – A letter of motivation, written in English (max. 2 pages). **In this document, applicants should indicate which of the proposed research areas and topics they are interested in and briefly justify their choices, proposing a detailed proposal.** They may also mention why they consider unibz and this Ph.D. programme suitable for their education and research activities.
 – The curriculum vitae (CV), in English and preferably prepared according to the European format, download here https://europass.cedefop.europa.eu/en/documents/curriculum-vitae).
 – A certificate of the master's degree/examination certificate or the equivalent degree obtained abroad, with an indication of the final grade and a list of the exams taken with the relative grade (transcript of records). In the case of an Italian university degree, the certification MUST be replaced by the substitute declaration or supplementary diploma.

Other documents to be included by applicants, if available:
 – Up to a maximum of 2 reference letters, written in Italian, German or English provided by a university lecturer or a researcher from a research institute, describing the work carried out and the quality of the same. Instead of letters, the names, and institutional contacts of up to 2 professional references may be provided.
 – A list of publications (published, in press, or submitted) and a digital copy of a maximum of 3 publications selected from the last 5 years (note that most weight is given to articles indexed in Scopus and/or the Web of Science).

The selection process consists of three steps:

1. Applications are first reviewed for completeness and eligibility by the competent unibz offices.

2. Complete applications that meet the basic admission requirements are then evaluated by the Evaluation Committee, which will take into consideration: the applicant's curriculum, letter of motivation, qualifications (including publications, if any), and the alignment between the candidate's profile/interests and the research areas of the Ph.D. programme. The Evaluation Committee will then draw up a list of applicants to be admitted to the 3rd stage of the selection process.

3. Each candidate will be interviewed to assess his/her knowledge and basic technical skills in one or more research areas of the Ph.D. programme, as well as her/his ability to communicate orally in English. The interview may be conducted, if necessary, by videoconference. The Evaluation Committee will rank the applicants on the basis of a comparative assessment.

The following points will be awarded:

– up to a maximum of 10 points for: the curriculum vitae, the letter of motivation and qualifications,
– up to a maximum of 10 points for: the congruence of the curriculum with the research areas of interest for the Ph.D.,
– up to a maximum of 20 points for: the interview.

The final points are the sum of the previous points obtained in the 3 categories described above with a maximum of 40. The final points are used to draw up the ranking list and to determine the candidates who will receive the scholarship. The minimum score to be admitted to the ranking list is 20/40.

Scholarships financed by external institutions:

If interested in one of the scholarships financed by external institutions, the applicant must explicitly state his/her interest in the letter of motivation.
Separate rankings may be drawn up for such scholarships. In any case, these rankings will be made up for those candidates who have been favorably ranked in the general ranking of merit and who have a scientific curriculum particularly appropriate to the indicated topic.

The final ranking list will be published on the unibz website www.unibz.it.

Examination dates

Description	Date	Place
Personal Interview	within 29th July 2024	Via Microsoft-TEAMS videoconferencing, unless otherwise communicated

Positions and scholarships:

Total number of positions available: **17**

Positions with university scholarship: **4**

Positions with other type of scholarship: **2**

Positions MD 360/2024 under PNRR: **6**

Positions without scholarship: 4

PhD scholarships bound to specific research topics/areas:

6 scholarships bound to a specific research topic with a minimum of a study period abroad of at least 6 months pursuant to MD 360/2024 funded by the European Union – NextGenerationEU:

Research topic:

1. Development of numerical methods for evaluating the contribution of lubricant flow on bearing efficiency to enable sustainable bearings solutions (in collaboration with Schaeffler Technologies AG & Co, Supervisor prof. Franco Concli)
2. Cybersecurity of AI-generated systems (in collaboration with SIAG Informatica Alto Adige Spa, Supervisor prof. Barbara Russo)
3. Printable electronics for environmental monitoring (in collaboration with Fondazione Bruno Kessler, Supervisor prof. Luisa Petti, dr. Andrea Gaiardo)
4. Shared human-robot control of heavy-lift aerial cargo drones (in collaboration with FlyingBasket Srl, Supervisor prof. Karl Dietrich von Ellenrieder)
5. EEG-based annotation of image material (in collaboration with Covision Lab SCARL, Supervisor prof. Angelika Peer)
6. Development of Digital Twin Solutions of machinery virtual commissioning and predictive maintenance (in collaboration with Röchling Automotive Italia, Supervisor dr. Luca Gualtieri, prof. Renato Vidoni)

2 scholarships linked to specific research topics:

1. Machine Learning and Artificial Intelligence methods applied to robotics for key alpine applications (financed by Eurac Research, supervisor Prof. Karl Dietrich von Ellenrieder)
2. Improving High-Speed Data Transfer with Ultra-Thin PCBs (financed by Fondazione Bruno Kessler, supervisor prof. Luisa Petti, dr. David Novel)

1 scholarship linked to a specific research topic (cofinanced by Istituto Italiano di Tecnologia):

1. Innovative Green Electronics for Assessing Plant Vitality and Fruit Ripeness in Precision Agriculture (supervisore Prof. Luisa Petti/co-supervisore Prof. Athanassia Athanassiou)