The Infotech Oulu Doctoral Program develops and fosters doctoral education and training in the general area of information technology. It is cross-disciplinary across the faculty borders covering research groups within the Faculties of Information Technology and Electrical Engineering, Medicine, and Biochemistry and Molecular Medicine. The training covers the related main subjects of doctoral training, in particular, communications engineering, computer science and engineering, electrical engineering, and information processing science. The Infotech Oulu Doctoral Program is one of programs of the University of Oulu Graduate School (UniOGS).

Infotech Oulu Doctoral Program consists of the following 16 research groups (the director of the group in parenthesis):

- Biomedical Engineering Group – BME (Professor Tapio Seppänen)
- Biometrics and Intelligent Systems – BISG (Professor Juha Röning)
- Center for Machine Vision Research – CMV (Professor Matti Pietikäinen)
- Circuits and Systems Group – CAS, (Academy Professor Juha Kostamovaara)
- Communications Signal Processing – CSP (Professor Markku Juntti)
- Electronics Materials, Packaging and Reliability Techniques – EMFART (Professor Heli Jantunen)
- Networking –NET (Professor Savo Glisic)
- New Generation Optoelectronics for Measurement Applications – NEGOMA (Senior Research Fellow Matti Kinnunen)
- Radio Access Technologies – RAT (Professor Matti Latva-aho)
- Community Imaging – COMAG (Professor Vassilis Kostakos)
- Human Interaction with Advanced Mobile Services and Intelligent Environments – INTERACT (Professor Kari Kuutti)
- Interactive Spaces – ISPACES (Professor Jukka Riekki)
- M-Group (Professor Markku Oivo)
- Mobile Services Design for All – MOBI (Professor Petri Pulli)
- Oulu Advanced Research on Software and Information Systems – OASIS (Professor Harri Oinas-Kukkonen)
- Urban Computing and Cultures – UCC (Professor Timo Ojala)

The Infotech Oulu Doctoral Program operates in four main areas. These are electronics, communications engineering, computer science and engineering, and software engineering and information systems.

The Electronics section consists of electronic circuit and system design, microelectronics, electronics manufacturing technology, physical electronics, electronic and optoelectronic measurement technology, and testing and disturbance techniques of electronics.

Communications engineering covers telecommunication systems from the architectures and implementations of transceiver to telecommunication networks, systems and services. The main research themes include broadband wireless access, short range communications and sensor networks.

The computer science and engineering section emphasizes information processing technology and its applications and software engineering. The topics include signal processing, machine vision, machine learning, intelligent systems, the development of software applications and their functionality, human-computer interfaces, ubiquitous environments, computer networks, mobile services, digital media, virtual reality techniques and biomedical engineering.

Software engineering and information systems include software processes, requirements engineering, software and system architectures, software testing, global software development, software and data intensive systems and services, human-computer interaction, participatory design, user-centered design, persuasive systems design, usability, social web, value co-creation, user driven innovation, customer engagement, ubiquitous environments, digital media, health informatics, behavior change support systems, and computer-supported cooperative work.

The Doctoral Program Board

The Infotech Oulu Doctoral Program Board has been appointed from the beginning of 2014 consisting of Professors Timo Rahkonen (Chair), Netta Iivari, Heli Jantunen, Timo Jämsä, Matti Latva-aho, Matti Pietikäinen and Juha Röning, Adjunct Professor Antti Tölli and doctoral student representative Mikko Hintikka. Professor Timo Rahkonen has been selected to the Doctoral Program Director.

From left: Timo Rahkonen, Netta Iivari, Mikko Hintikka, Juha Röning, Antti Tölli and Matti Pietikäinen.
In 2016, the Infotech Oulu Doctoral Program had granted 32 doctoral student positions from the University of Oulu: twenty positions for 2014 – 2017 and 12 positions for 2016 – 2019. From these positions, most are allocated only for research groups selected to Infotech Oulu for 2014 – 2017 (first nine in the list above) and the rest for all 16 research groups involved in the program. These doctoral student posts altogether represented EUR 864 000 in salary costs in 2016.

Additional EUR 80 000 was obtained from the University of Oulu for arranging doctoral courses and for other costs and EUR 40 000 for coordination in 2016. The total budget of the doctoral program was EUR 984 000. In addition, the research groups contribute the doctoral program through the work of the staff.

There were a few unexpected changes for funding in near future. The University of Oulu cut our already granted doctoral student positions for 2017 by almost 5 person years and for 2018 and 2019 the cuts will be even higher with these posts. However, the new projects selected to Infotech Oulu for years 2018 – 2021 will have new doctoral student positions for that period.

**Funding**

To gain two credits, a graduate student must follow 20 hours of lectures and make a written summary of one lecture. The following lectures were held in 2016.

- Professor Alessandro Aurigi, Plymouth University, UK - Augmenting or neglecting? How the smart city is poor at addressing urban space and place, and what urban design can offer
- CNRS Associate Professor Marco Di Renzo, CentraleSupélec, University of Paris Sud, France - On system-level analysis & design of cellular networks: the magic of stochastic geometry (from modeling to experimental validation)
- Professor Beiji Zou, Central South University, China - The significance of the analysis of color fundus image and a survey of the retinal vessel segmentation
- Professor Henning Schulzrinne, Columbia University, USA - 5G: What can we learn from the previous four generations
- Shabbir Ali, Telecom Paris Tech, France - Learning in near-potential games with applications to load balancing in heterogeneous networks
- Dr. Guido Giunti, Salumedia, Spain - Gamification: Opportunities in healthcare
- Dr. Olli Salmela, Nokia - Reliability aspects in the new telecom world
- Professor Fadi Dornaika, University of the Basque Country, Spain - Machine learning approaches to face image analysis and image classification
- Professor Yoram Baram, Technion, Israel Institute of Technology - Sensory feedback for gait improvement in movement disorders patients
- Professor Moncef Gabbouj, Tampere University of Technology, Finland - Machine learning and optimization tools for big multimedia data analytics
- FiDiPro Professor Xilin Chen, Chinese Academy of Sciences, China - Why a dog Is a dog – a view on image retrieval
- Professor Michael Gastpar, EPFL, Lausanne, Switzerland - Information-theoretic caching

**The Infotech Oulu Lecture Series**

Students and Doctoral Theses

The supervisors of the doctoral program come from the research groups of the Infotech Oulu Doctoral Program. The students who have a supervisor from these groups, and do not belong to any other doctoral program of UniOGS, are considered as the students of Infotech Oulu Doctoral Program. According to the policy of the University of Oulu Graduate School a doctoral student can belong to only one doctoral program. Based on our last statistics, the doctoral program has about 270 active doctoral students.

The output was 31 doctoral theses. Funding from the Infotech Oulu Doctoral Program positions was used for nine of them: Sanna Aikio, Erkki Harjula, Pekka Keränen, Brigitte Lanz, Vu Thuy Dan Nguyen, Xiang Su, and Sami Varjo. All the theses can be found in electronic format on the web from [http://www.oulu.fi/infotech/doctoral_program/all_dissertations](http://www.oulu.fi/infotech/doctoral_program/all_dissertations).

**Teaching Activities**

Strong research contacts with other universities and research institutes are utilized in arranging lecturers for the courses. Several lectures (the Infotech Oulu Lecture Series) and intensive courses are held annually. These all provide a valuable extension to the other doctoral courses in information technology provided by the university.

**Intensive courses and workshops**

**Electronics**

- Dr. Eugene Avrutin, University of York, UK - Foundations of waveguide and integrated optics
- Dr. Manoj Raama Varma, Senior Principal Scientist, CSIR-National Institute for Interdisciplinary Sciences and Technology (CSIR-NIIST), Trivandrum, India - Advanced magnetic materials
- Advanced Materials for Environmental Monitoring and Sustainability Workshop 13
- Dr. Nirmalya Ghosh, Indian Institute of Science Education and Research (IISER) Kolkata, India - Optical polarimetry in biophotonics and plasmonic research
- Professor Janis Spigulis, University of Latvia - Biophotonic technologies
- Dr. Tarmo Ruotsalainen, Ericsson - CMOS mixed-signal VLSI design
- Associate Professor Yuriy Ushenko, Chernivtsi Na-
tional University, Chernivtsi, Ukraine - Modern methods and resources of laser polarimetric diagnostics of biological tissues
- Associate Professor Danny van Noort, Linköping University, Sweden and Universidad de los Andes, Chile - Micro and nanotechnology applied to life sciences

Communications engineering
- Dr. Eric Klumperink, University of Twente, The Netherlands - CMOS software defined radio transceivers
- Associate Professor Harish Krishnaswamy, Columbia University, NY, USA - Millimeter-wave integrated circuits 60 GHz and beyond
- Professor Bhaskar Rao, UC San Diego, Jacobs School of Engineering, USA - Sparse signal recovery and compressed sensing
- Professor Erdal Arıkan, Bilkent University, Ankara, Turkey - Recent developments in channel coding
- Dr. Anil Fernando, University of Surrey, UK - Video compression and communications for mobile networks

Computer science and engineering
- Sixteenth International Crisis Management Workshop (CriM’16) and Oulu Winter School
- Professor Jan Kybic, Czech Technical University, Prague, Czech Republic - Numerical optimization, September 13-15
- UBISS 2016 - 7th International UBI Summer School 2016
- Prof. Nigel Davies & Dr. Sarah Clinch, Lancaster University, UK - Ubicomp in the wild: developing and deploying pervasive displays
- Professor Hans Gellersen, Lancaster University, UK & Dr. Eduardo Velloso, University of Melbourne, Australia - Eyework: designing interactions with eye movements
- Professor Giulio Jacucci, University of Helsinki & Petri Savolainen, HIIT - Collaboration and personal devices around interactive displays
- Professor Steve LaValle & Dr. Anna Yershova, UIUC, USA - Next generation virtual reality: perception meets engineering

Software engineering and information systems
- MD Guido Giunti - Game design thinking for healthcare
- Connected Health Data Training School
- Professor Barbara Czarnecka, University of Gothenburg, Sweden - From field to desk: A transdisciplinary qualitative method course
- Dr. Paul Ralph, University of Auckland, New Zealand - Developing and evaluating theories in software engineering
- Dr. Onur Dikmen, University of Helsinki - Learning Markov Random Fields from data

Co-operation
The following external organizations have provided co-financing or other support for the courses and workshops:
- Advanced Materials Doctoral Programme, EIT Raw Materials 1)
- UBI (UrBan Interactions) research program 2)

Course Information
Information about the courses is distributed through our web-pages and by email. The web address for the doctoral program is http://www.infotech.oulu.fi/doctoral_program.

Organizational Changes in 2017
There are major changes in the structure of doctoral education in the University of Oulu starting from 2017. This concerns also Infotech Oulu Doctoral Program. From 2012, there were three doctoral training committees in UniOGS. Infotech Oulu Doctoral Program was under the Doctoral training committee for Technology and Natural Sciences. From this committee, the Doctoral training committee for Information Technology and Electrical Engineering is a spin-off to the fourth training committee in the new structure.

In the end of 2016 the number of doctoral programs in the UniOGS was nine, and the Infotech Oulu Doctoral Program was one of them. In the new system, there are only one doctoral program for each doctoral training committees with the same name. This means that the new name for us is the Information Technology and Electrical Engineering Doctoral Programme. The scope of the program will be about the same.

The structure of the program is similar to the structure of the corresponding training committee. The major subjects are
- Electrical engineering, photonics, Electronics design, Electronics materials & components, Technical mathematics
- Communications engineering
- Computer science and engineering
- Information processing science

68 students from 12 countries attended UBISS 2016 (7th International UBI Summer School 2016) held in Oulu on June 13-18, 2016.