ETH *zürich*

Master of Science
Electrical Engineering and Information Technology

D ITET

Welcome

Electrical engineers continue to invent and to shape the future of the digital world. Electrical engineers create "the smart stuff" in cell phones, computers, cameras, automobiles, robots, medical laboratory equipment, and tons of other things. And they invent the electrical future of sustainable energy.

The Department of Information Technology and Electrical Engineering of ETH Zurich is proud to offer a Master's programme that brings students to the forefront of the field. The Master's programme in Electrical Engineering and Information Technology is the modern version of the classical "Electrical Engineer ETH" and the normal continuation of our Bachelor's programme; it is also the preferred path towards a doctoral degree at our department for students from outside ETH.

Each student has a tutor (a professor), who helps with the selection of courses. The courses and projects permit a specialization in one of the following areas:

– Communications
– Computers and Networks
– Electronics and Photonics
– Energy and Power Electronics
– Signal Processing and Machine Learning
– Systems and Control

However, courses can be selected freely, subject to approval by the tutor.

Courses are offered in English, and the Master's degree can be obtained without any knowledge of German.

Curriculum Structure

The Master's programme is a full-time study programme for four semesters. The programme consists of courses, a semester project, an internship (optional) and a Master's thesis. All the courses and the semester project are usually completed in three semesters. The Master's thesis takes an additional six months (full-time).

At least 120 credit points ECTS must be acquired. (One credit point corresponds to 25–30 hours of work.)

Each student must find a tutor (a professor of the department) and have the course selection approved by the tutor not later than four weeks after the beginning of the first semester.

Most of the examinations take place in January/February and in August (between semesters).

"We are working on cutting-edge solutions to the complex challenges that will confront our world in the fields of information and communication, electronics and photonics, energy, and health."

Prof. John Lygeros, Automatic Control Laboratory, D-ITET

Prof. Gabriela Hug (centre), Power Systems Laboratory, working with students

Courses (at least 66 credit points)
Courses permit a specialization in one of our areas of research. They can be selected freely, subject to approval by the tutor. A typical full-size course gives 6 credit points. All courses and their credit points are listed in the course catalogue *(www.vvz.ethz.ch)*.

Students must obtain at least 24 credit points in core courses and 40 credit points in elective courses. At least 2 credit points must be obtained by courses from the Department of Humanities, Social, and Political Sciences (D-GESS).

Semester Project (12 credit points)
The semester project gives students hands-on research experience and the opportunity to improve their experimental and/or programming skills. The semester project should take about half of a student's time during one semester. A second semester project is optional, subject to approval by the tutor.

Projects are offered by the individual laboratories of the department.

Internship in Industry
(12 credit points, optional)
An optional internship in industry provides the students with valuable insights into places where they can develop their future career. The internship must have a duration of at least 12 weeks, should be primarily technical and is typically carried out in a company. The internship is full-time and cannot be combined with classes.

Upon successful completion, students can obtain 12 credit points for the internship.

Master's Thesis (30 credit points)
The Master's programme concludes with a Master's thesis (6 months full-time). Students should complete all other parts of the Master's programme before the beginning of the Master's thesis.

Theses are offered by the individual laboratories of the department.

Areas of Specialization

Communications

Telecommunications is about transmitting "information" from "here" to "there" over wires, optical fibres, or by means of electromagnetic waves in free space. The challenge is to do this efficiently and reliably despite disturbances and imperfections of the medium.

The design of modern communication systems is firmly based on the fundamental principles of information theory that were discovered by Claude Shannon and that continue to be a vibrant research area by themselves.

The exploitation of these ideas has been enabled both by the amazing progress in semiconductor technologies and by ever more sophisticated statistical signal processing.

Indeed, as one of the largest industries, communications has been driving forward both semiconductor technologies and methods for signal processing.

The courses and projects in this area cover fundamentals and applications in communication systems, information theory, electromagnetic wave propagation, and signal processing.

Computers and Networks

Computers are inside everything nowadays, and many gadgets (including cell phones, laptop computers, cars, etc.) actually contain several special-purpose computers. How to design such "embedded" computers and how to make them talk to each other and to the Internet are key issues in the digital world.

Additional challenges arise if computers are connected by wireless networks, especially if the computers are inside moving things. How can we reliably distribute data across, or aggregate data from, such a shaky network?

And then there is the threat of malicious hackers, which is driving intense research in cryptography and system security.

The courses and projects in this area cover the fundamentals of embedded computers and their communication to each other and the Internet, including the challenges of wireless networks and security issues.

Electronics and Photonics

All the smartness of our digital world is embodied by semiconductor electronics. Modern microchips contain billions of transistors, and the ability to design such complex integrated systems is both a skill in great demand and an ever-growing challenge.

Also of great and growing interest are sensors and circuits at the interface between the real and the digital world, including optoelectronic devices for imaging and communication, circuits for wireless communication, sensing, signal processing, machine learning, and biomedical applications.

Many disciplines need to be mastered for successfully designing and manufacturing chips: semiconductor physics, circuits, algorithms, computer architectures, computer-aided design and simulation, manufacturing and testing.

The courses and projects in this area cover both fundamentals of electronics and photonics as well as analogue and digital chip design at the forefront of technology.

Energy and Power Electronics

The generation and the distribution of electrical energy and its use in electrical motors and other appliances marked the very beginning of electrical engineering. Impending changes in the power industry and the needs of sustainable energy are moving these topics centre stage once more. More efficient converters and motors of all sizes (up to large-scale power plants and down to micromechanics) are needed. Suitable control policies for the coexistence of small local power generators, large power stations, and new types of loads such as electrical vehicles must be developed. Novel power electronic devices, new materials, and state-of-the-art information technology offer opportunities for new solutions to these challenges.

The courses and projects in this area cover both the fundamentals and applications of the generation and the distribution of electrical energy and will prepare the students to shape the future of electrical power systems and mechatronics.

Signal Processing and Machine Learning

Signal processing is about the analysis and synthesis of sound, images, and other physical quantities, and about extracting "information" from almost any sort of data.

Modern signal processing substantially overlaps with machine learning, which is a collection of ideas and mathematical techniques (with origins in statistics, physics, electrical engineering, and computer science) to "learn" from data. The related disciplines of communications, control, and signal processing together provide most of the "intelligence" of "intelligent" devices present and future.

The courses offered in this area provide solid foundations and ample options for specialization.

Systems and Control

The mathematical theory of dynamical systems studies the behaviour of physical systems (mechanical, electrical, etc.) over time. Control theory is a branch of systems theory concerned with regulating the dynamics of a system in a desired way using online measurements. Classical applications of control theory include aviation, robotics, chemical plants, and electrical power systems. More recent applications include autonomous driving, traffic control on the Internet, social networks, systems biology, wireless communication, and many more.

The courses and projects in this area range from the theoretical foundations of systems theory to algorithms and computer tools for solving practical control problems in applications from industrial processes to infrastructure networks and social and biological systems.

Prospective Students

How to Apply

Students with a Bachelor's degree from our department are admitted without formal application; the electronic registration *(www.mystudies.ethz.ch)* suffices.

All other candidates must submit an application. Candidates should have a Bachelor's degree in electrical engineering from a recognized university or from a Swiss university of applied sciences. All applications will be subject to individual evaluation. For successful applicants additional courses may be required from our Bachelor's programme (up to 60 credit points ECTS). Please refer to the Admissions Office *(www.admission.ethz.ch).*

Tuition and Cost of Living

The tuition fee is 730 Swiss francs per semester. However, students need to budget about 22,000 Swiss francs per year for living in Zurich (accommodation, living expenses, health insurance, etc.). A very limited number of scholarships are available for applicants with outstanding academic records. For more detail see: *www.ethz.ch/en/studies/financial*

Continuing with Doctoral Studies?

Good Master's students may consider continuing their studies towards a doctoral degree. Doctoral students are generally well paid. Applications should be made directly to a professor.

Department of Information Technology and Electrical Engineering

The Department of Information Technology and Electrical Engineering of ETH Zurich is active at the forefront of research throughout the broad area of electrical engineering, ranging from wireless communications to electronics and from control theory to computers inside things. In addition, the department has a strong bio-engineering section. The department is committed both to basic research and to applied research, and countless collaborations with industry are a matter of course.

The faculty of the department consists of more than 40 professors, who are organized into 19 laboratories ("institutes") with over 400 doctoral students in total. The facilities both for research and for teaching are excellent. Each year the department awards over 200 Bachelor's degrees and about the same number of Master's degrees.

Student Life

Zurich is consistently rated as one of the best places in the world to live. The city is situated on beautiful Lake Zurich with the mountains less than an hour away. Zurich is clean and safe, has an excellent public transportation system and a high standard of living. The city has an international flair and offers many cultural activities as well as a vibrant nightlife. Most Swiss are multilingual and English is often the language of choice. Although German is not required for the Master's programme, some knowledge will make navigating the city and the university much easier. Language courses for students are available at: *www.sprachenzentrum.uzh.ch/en*. ETH Zurich itself offers a wide variety of sports, music, recreational and continuing education opportunities.

An overview can be found at: *www.ethz.ch/en/campus*

Information on every topic of life in Zurich is available in English at: *www.zuerich.com/en*
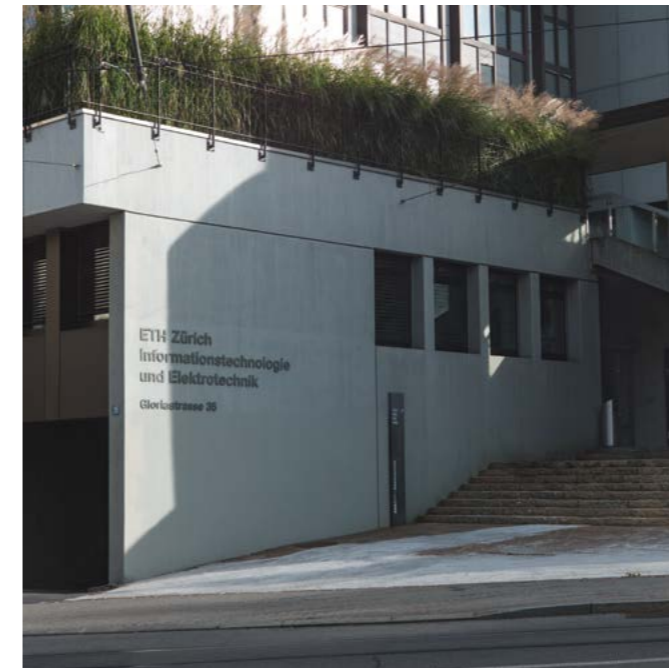
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