# Graduate Fields
# Definition and Proposal Template

**Definition**

In graduate programs, field refers to an area of specialization or concentration (in multi/interdisciplinary programs a clustered area of specialization) that is related to the demonstrable and collective strengths of the program's faculty. Institutions are not required to declare fields at either the master's or doctoral level. Institutions may wish, through an expedited approval process, to seek the endorsement of the Quality Council.

**Graduate Field Proposal Guidelines**

**1. Indicate the name of the field being proposed and identify the parent program.**

*Field*: Electrical Engineering
*Parent program*: MASc in Electrical and Computer Engineering

**2. Provide a description of the field (its intellectual focus, etc.) including the appropriateness and consistency of the field name with current usage in the discipline or area of study.**

Electrical engineering refers to the study and application of electric power, electronic circuits, electro-magnetics and electrical signals. The study of electrical engineering is paramount in our technological based world; it facilitates the development of all our electronic devices and enables reliable and efficient power delivery to our homes and offices. Within the electrical engineering field of the graduate program, students will significantly expand and deepen their understanding of the theory and practice of electrical engineering in at least one of the following areas: power engineering and energy systems, electronics, and bio-medical devices. Research focuses on the development of advanced high power conversion power architectures, intelligent smart-grid control and protection techniques, energy efficient electronic devices, renewable energy, and innovative biomedical sensors for clinical applications, and advanced analog and digital integrated circuits (ICs) for high-speed communications and low-power computation.

**3. Comment on the relationship of the admission requirements for the field to those of the parent program. If the same, describe the program admission requirements. If different, describe the field admission requirements, indicate how they are different from those of the parent program, and provide a rationale for the difference in relation to the focus and learning outcomes of the field.**

The admission requirements for the field are the same as those of the parent program. Since these requirements are being slightly amended to include mentioning of software engineering for applicant credentials, please refer to Appendix A of the Major Modification Proposal.

**4. Comment on the relationship of the curricular requirements for the field to those of the parent program. If the same, describe the program requirements. If different, describe the field requirements, indicate how they are different from those of the parent program, and provide a rationale for the difference in relation to the focus and learning outcomes of the field.**

The curricular requirements for the field are the same as those of the parent program. Since these requirements are being changed in terms of number of courses and breadth requirement, please refer to Appendix A of the Major Modification Proposal.

**5. Provide a list of courses that will be offered in support of the field. The list of courses must indicate the unit responsible for offering the course (including cross-lists and integrations, as appropriate), the course number, the credit value, the short course description, and whether or not it is an existing or new course. For existing courses, the frequency of offering should be noted. For new courses, full course proposals are required and should be included in the proposal as an appendix. (The list of courses may be organized to reflect the manner in which the courses count towards the program/field requirements, as appropriate; e.g. required versus optional; required from a list of specified courses; specific to certain concentrations, streams or fields within the program, etc.)**

All the courses listed below are optional. They are all existing courses. The supervisor plays an important role in the course selection and will normally encourage students to take these courses.

*Course*: EECS 5612 3.0
*Title*: Digital Very Large Scale Integration
*Short course description*: A course on modern aspects of VLSI CMOS chips. Key elements of complex digital system design are presented including design automation, nanoscale MOS fundamentals, CMOS combinational and sequential logic design, datapath and control system design, memories, testing, packaging, I/O, scalability, reliability, and IC design economics.
*Number of offerings (in last five years)*: 3

*Course:* EECS5640 3.0
*Title:* Medical Imaging Techniques
*Short course description:* Principles and Applications This course introduces principles of medical imaging, focusing on major imaging modalities including ultrasound, X-ray radiography, computed tomography, magnetic resonance imaging, and nuclear medicine imaging. The course covers the physics and engineering aspects of how various imaging signals are acquired and processed in order to form medically useful images. The course also covers essentials of medical image analysis.
*Number of offerings (in last five years)*: New course

*Course*: EECS 6601 3.0
*Title*: Nanoelectronics
*Short course description*: The sustained demand for increased memory and computational power has driven the physical size of electronic components to nanoscale dimensions. The need to investigate size effects and to find viable ways to manufacture at the nanoscale has also led to the discovery of new phenomena and functionality. This course covers electronic transport and other properties in nanoscale systems, devices, characterization and fabrication techniques. Topics to be covered include quantum confinement, quantum dots, nanowires, 2D electron gases, single electron transistors, spintronic devices, electronic transport and optical properties, nanoscale materials, top-down and bottom-up fabrication approaches.
*Number of offerings (in last five years)*: 2

*Course:* EECS6602 3.0
*Title:* Printed Electronics

*Short course description:* Printed electronics is a novel microfabrication technology that promises to fabricate low-cost microelectronics on large-area, flexible substrates such as plastic or paper. Potential applications include RFID tags, bendable displays or wearable sensors. Students learn the fundamentals and recent developments in the field. Topics covered include printable materials, printing physics, various printing methods and printed devices. Prerequisite: EECS 3610 or equivalent.
*Number of offerings (in last five years)*: 1

*Course:* EECS6606 3.0
*Title:* Low Power ASIC Design
*Short course description:* This course introduces several important concepts and techniques in low power ASIC design. It covers VSLI design methodology, ASIC design flow, low power digital circuit design principles, timing closure in ASIC, power analysis, and power optimization. Student will have the opportunities to perform circuit design tasks using the state-of-the-art EDA tools. The concepts are enhanced through readings and projects.
*Number of offerings (in last five years)*: New course

*Course:* EECS6611 3.0
*Title:* Mixed-Signal Microsystems Design
*Short course description:* This course highlights design and analysis of major mixed-signal microsystems and their building blocks. Topics include introduction to design and analysis of switched-capacitor circuits, sampling circuits and architectures, comparators, continuous-time and discrete-time active filters, fundamentals of digital-to-analog and analog-to-digital data conversion, Nyquist-rate, multi-step, pipeline, and oversampled A/D architectures.
*Number of offerings (in last five years)*: 1

*Course:* EECS6613 3.0
*Title:* Advanced Analog Integrated Circuit Design
*Short course description:* This course presents principles of advanced analog and mixed-signal integrated circuits and discusses hand analysis, simulation, and characterization techniques for them. It includes subjects such as metal-oxide-semiconductor (MOS) transistor models for analog design, principles of random electronic noise, low-noise amplifier design, amplifiers stability and settling time, comparators, offset cancellation, wide-swing current references, bandgap reference, sampling circuits, and analog scaling.
*Number of offerings (in last five years)*: 1

*Course*: EECS 6701 3.0
*Title*: High Frequency Power Electronic Converters
*Short course description*: This course discusses the fundamentals of loss-less switching techniques in high frequency power converters: zero-voltage switching and zero-current switching. The course then focuses on various resonant converter topologies and soft-switching converters with auxiliary storage elements. The course then discusses various control techniques used in high frequency power converters. Special emphasis is placed on the design techniques using practical examples.
*Number of offerings (in last five years)*: 2

*Course*: EECS 6704 3.0
*Title*: Smart Distribution Grids
*Short course description*: The following topics are covered: introduction to electric power distribution system structure and components; concept of distributed and renewable energy resources (DG); distribution system load/DG characteristics and modelling; integration of DG in power flow analysis;

voltage and reactive power planning and control with consideration of DG; self-healing mechanisms; microgrids concept, planning, operation, and energy management.
*Number of offerings (in last five years)*: 1

*Course:* EECS6705 3.0
*Title:* Power System Transients
*Short course description:* Electromagnetic-transient modelling of power system is of the most crucial requirements for many power system studies and engineering practices. This course covers fundamentals of the transient phenomena such as lightning, faults, switching, and discusses the principles of protecting power system equipment from the transient overvoltages. Electromagnetic transient models of power equipment are presented and advanced modelling features are discussed.
*Number of offerings (in last five years)*: 1

*Course:* EECS6706 3.0
*Title* High Voltage Engineering
*Short course description:* This course covers the fundamentals of high-voltage engineering and the associated phenomena. The methods for generation and measurements of high voltage ac, dc, and impulse voltages are presented. The high-voltage electromagnetic fields and the impacts on the insulation system design are also described. The practical tests for insulation performance evaluation and some applications of high-voltage engineering are discussed.
*Number of offerings (in last five years)*: New course

*Course:* EECS6707 3.0
*Title:* Power System Protection
*Short course description:* This is an introductory course to power system protection. The topics include: fault analysis of power grids, the role of protection systems in power grids, different types of overcurrent relays and corresponding coordination strategies, impedance-based protection for transmission lines, differential protection for transformers, buses, machines, and lines, application of computer simulation for protection studies.
*Number of offerings (in last five years)*: New course

*Course*: EECS 6801 3.0
*Title*: Advanced Microelectronic Biochips
*Short course description*: This course offers an introduction to the Biochips. This course takes a multi-path approach: micro-fabrication techniques, microelectronic design and implementation of bio interfaces offering a vital contemporary view of a wide range of integrated circuits and system for electrical, magnetic, optical and mechanical sensing and actuating devices and much more; classical knowledge of biology, biochemistry as well as micro-fluidics. The coverage is both practical and in depth integrating experimental, theoretical and simulation examples.
*Number of offerings (in last five years)*: 1

*Course:* EECS6802 3.0
*Title:* Implantable Biomedical Microsystems
*Short course description:* This course provides an introduction to implantable biomedical microsystems, their design, and applications. Engineering design, implementation, and test of a wide variety of biomedical implants is discussed. This includes system-level and architectural design, circuit design (analog and mixed-signal, generic/application-specific), wireless interfacing (power and bidirectional data telemetry), hardware-embedded biological signal processing, design & implementation of non-circuit modules such as microelectrode arrays.

*Number of offerings (in last five years)*: 1

*Course*: EECS 6803 3.0
*Title*: Micro-fluidics for Cellular and Molecular Biology
*Short course description*: This course offers an introduction to the micro-fluidics for life science applications. This course offers a unique opportunity to all science, health and engineering students to learn the fundamental of micro-fluidic technologies for a variety of cellular and molecular applications. The coverage is both practical and in depth integrating experimental, theoretical and simulation examples.
*Number of offerings (in last five years)*: 1

**6. Comment on the expertise of the faculty who will actively support/participate the field and provide a Table of Faculty by field, as follows:**

All faculty members mentioned in the table below conduct research in the field and supervise graduate students in the field.

| Faculty Member & Rank | Home Unit | Primary Field | Category |
|---|---|---|---|
| Mokhtar Aboelaze, Associate professor | EECS | Computer Engineering | Associate member |
| Robert Allison, Professor | EECS | Computer Engineering | Full member |
| Gene Cheung, Associate professor | EECS | Electrical Engineering | Full member |
| Andrew Eckford, Associate professor | EECS | Electrical Engineering | Full member |
| Hany Farag, Assistant professor | EECS | Electrical Engineering | Full member |
| Ebrahim Ghafar-Zadeh, Assistant professor | EECS | Electrical Engineering | Full member |
| Gerd Grau, Assistant professor | EECS | Electrical Engineering | Full member |
| Ali Hooshyar, Assistant Professor | EECS | Electrical Engineering | Full member (on leave) |
| Richard Hornsey, Professor | EECS | Electrical Engineering | Full member |
| Michael Jenkin, Professor | EECS | Computer Science | Full member |
| Hossein Kassiri, Assistant professor | EECS | Electrical Engineering | Full member |
| Matthew Kyan, Associate professor | EECS | Electrical Engineering | Full member |
| John Lam, Assistant Professor | EECS | Electrical Engineering | Full member |
| Peter Lian, Professor | EECS | Electrical Engineering | Full member |
| Sebastian Magierowski, Associate professor | EECS | Electrical Engineering | Full member |
| Simone Pisana, Associate professor | EECS | Electrical Engineering | Full member |
| Afshin Rezaei Zare, Associate professor | EECS | Electrical Engineering | Full member |
| Ali Sadeghi-Naini, Assistant professor | EECS | Electrical Engineering | Full member |
| Amir Sodagar, Associate professor | EECS | Electrical Engineering | Full member |
| Hina Tabassum, Assistant professor | EECS | Electrical Engineering | Full member |
| Ping Wang, Associate professor | EECS | Electrical Engineering | Full member |

*Note: Up-to-date CVs of faculty who will actively participate in delivering the graduate program must be included as an appendix.*

**7. Comment on the projected in-take into the field, including the anticipated implementation date (i.e. year and term of initial in-take), and indicate if the projected in-take is within or in addition to the existing enrolment targets for the parent program.**

The in-take into the field was 22 students this year. Given that the faculty complement in Electrical Engineering is reaching steady state, this number is expected to increase somewhat in the near future. This in-take is within the existing enrolment targets for the parent program.

The field highlights Electrical Engineering within the broad spectrum covered by the parent program (from Electrical Engineering to Computer Science) and, therefore, will be helpful for recruitment of new students. Within the highly regulated discipline of engineering, recognition of the type of engineering is very valuable for graduates when seeking employment.

**8. Comment on the impact of the field on the parent program, focusing on the extent of diversion of faculty from existing graduate courses and/or supervision, as well as the capacity of the program to absorb any anticipated additional enrolment.**

The introduction of this field will *not* impact the parent program. The course requirements are not changed. There is sufficient capacity for supervision.

**9. Support statements**

- **from the relevant Dean(s)/Principal, with respect to the adequacy of existing resources necessary to support the new field, as well as the commitment to any plans for new/additional resources necessary to implement and/or sustain the new field**
- **from the relevant Faculties/units/programs confirming consultation on/support for the new program, as appropriate**
- **from professional associations, government agencies or policy bodies with respect to the need/demand for the proposed program, as appropriate**