RYERSON UNIVERSITY

**Graduate Program in Electrical and Computer Engineering**

# Departmental Guidelines[1] for Doctoral Candidacy and Dissertation Exams

Each student in the doctoral program in the Electrical and Computer Engineering Graduate Program is required to complete EE9100: Candidacy Examination. The examination is to determine whether the candidate has the appropriate knowledge and expertise to undertake a dissertation in the selected field or area of study.

In order to have a fair and transparent process to examine the student, the departmental graduate program has developed the following guidelines.

## Candidacy Examination

- The candidacy examination must be held within 20 months from the date of initial registration. It is usually held in the 4th term of the residence.
- Examination Committee will conduct the examination. The Committee consists of:
  - Supervisory Committee[2] members, and
  - Program Director (or delegate) as Chair, and
  - if required, one additional SGS member from outside of the student's research group will be included. This member will be included at the discretion of the supervisor in consultation with the student.
- The examination will consist of two parts (i) written examination and (ii) oral examination. The exam is not open to public and confidential.
- All the members of the committee are voting members. In case of co-supervision, co-supervisors collectively have one vote.

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[1] These guidelines have to be used along with the *Guidelines for Candidacy Examinations in Doctoral Programs in Science and Engineering.*

[2] Prior to the Candidacy Exam, the Supervisory Committee composing of 3-4 members must be setup. The student’s supervisor will recommend to the Program Director the appointment of the Supervisory Committee.

**Part I: Written Examination**

Suggested format is:

- Written exam will be closed book. Any aids (e.g., formula or tables) have to be included with the question.
- Each examiner will set his/her question(s) that could be completed in 45 minutes.
- Each student is required to write exam on four subjects.
- The duration of the written exam is 3 hours.

- Materials to be examined are normally at senior undergraduate and junior graduate level in the related area(s) of research. The following list of courses (Ryerson courses that cover the subject areas) has been identified for the examination:

  - Signals and Systems (ELE532)
  - Digital Signal Processing (ELE792)
  - Probability and Stochastic Processes (MTH514)
  - Communication Systems (ELE635)
  - Control Systems (ELE639)
  - Digital Communication (ELE 745)
  - Electronic Circuits (ELE504)
  - Microprocessor Systems (ELE538)
  - Digital Integrated Circuits (ELE734)
  - CMOS Integrated Analog Circuits (ELE 704)
  - Operating Systems (COE518)
  - Computer Organization and Architecture (COE608)
  - Object Oriented Engineering Analysis and Design (COE 618)
  - Electromagnetics (ELE531)
  - Energy Conversion (ELE637)
  - Power Electronics (ELE754)
  - Power Systems (ELE846)

  The course descriptions of the above courses are given in the Appendix.

Effective September 1, 2007, The ELCE graduate program will follow these steps and guidelines in administering the written exam.

- In each term, all the written exams will be scheduled to be held on the same date/time, if possible.
- Each student, after consultation with the supervisor, must submit to the Graduate Program Director names of the four courses from the approved list that the student will be tested on.
- The exam will usually be prepared by the course coordinator or a faculty member who teaches the course.

- Each examiner is required to give the exam question to the Graduate Program Director at least two weeks prior to the exam date.
- Any aids (e.g., formula or tables) have to be included with the question.
- The same faculty member who prepared the question will mark the exam.
- The numerical mark i.e., out of 100, along with any comments from the examiner will be reported to the Exam Committee Chair who will then distribute the exam papers and comments to all the committee members.
- The Candidacy Exam Committee makes the decision for the written part of the Candidacy Exam based on the reported results by the examiners as well as their evaluation.

- **A final copy of the dissertation proposal** must be submitted to the Chair of the Examination Committee within three weeks after the day of the written exam. For those students started in the Fall semester, the written exam is usually held in the last week of October and final research proposal must be submitted before the 3rd week of November.

**Part II: Oral Examination**

- It is suggested to be held within 6 weeks from the written exam date.
- The suggested duration of the oral examination is 2 hours.
- Examination will commence with the presentation of student's research proposal. The suggested duration of the presentation is 30 minutes and it should focus mainly on the proposal.
- The candidate will then be examined by the committee. The oral questions will be related to the candidate's written examination and dissertation proposal.

Final Grade for EE9100: Candidacy Examination: see the Guidelines for Candidacy Examinations in Doctoral Programs in Science and Engineering. *ELCE Program Specific:* If a candidate gets two or more negative votes in the Candidacy Exam, fail grade will be assigned.

**Departmental PhD Dissertation Exam**

For each PhD candidate, the supervisory committee must conduct an oral exam for the dissertation which should be scheduled at least two months before the intended date of the final dissertation exam. The internal oral exam will be open to the public.  Based on the satisfactory performance in the exam, Graduate Program Director will recommend to SGS Dean for final dissertation exam. Exam report form is attached.

## Appendix: Ryerson Course Outlines

**ELE 504 Electronic Circuits II**
An advanced course on the analysis and design of electronic circuits. The topics to be studied include amplifier characteristics, amplifier applications, frequency responses , filters and tuned amplifiers, oscillators, power amplifiers and output stages, linear regulators, switching regulators, signal generators, and digital circuits. Circuit applications to such areas as instrumentation, signal processing and conditioning, communication, and control are considered. Important concepts are illustrated with laboratory experiments.

**MTH 514 Probability and Stochastic Processes**
Introduction to probability theory and stochastic processes. Topics covered include: elements of probability theory, conditional probability sequential experiments, random variables and random vectors, probability density, function cumulative density functions, functions of random variables, expected values of random variables, transform methods in random variable, reliability of systems, joint and marginal probability, correlation, confidence intervals, stochastic processes, stationary and ergodic processes, power spectral density, sample processes.

**COE 518 Introduction to Operating Systems**
Topics include: Operating systems basic concepts. Hardware and software features required for real time vs. traditional operating systems. Process management; scheduling, inter-process communication and synchronization, process starvation, deadlocks. Memory management, virtual memory, files systems, real-time operating system including algorithms. The major lab project will involve developing operating system modules.

**ELE 531 Electromagnetics**
Time-varying fields and Maxwell's equations, boundary conditions, retarded potentials. The wave equation. The uniform plane wave, wave polarization, wave reflection. Transmission lines, the Smith chart. Rectangular waveguides. . Radiation from short dipoles, the half- and quarter-wavelength antennas, the radiation resistance. Basic microwave measurements.

**ELE 532 Signals and Systems**
This course deals with the analysis of continuous-time and discrete-time signals and systems. Topics include: representations of linear time-invariant systems, representations of signals, Laplace transform, transfer function, impulse response, step response, the convolution integral and its interpretation, numerical convolution, Fourier analysis for continuous-time signals and systems.

**ELE/COE 538 Microprocessor Systems**
This course introduces students to small microprocessor-based systems, with an emphasis on embedded system hardware and software design. Topics will include microprocessor architecture and structure, with an overview of 8- 16- and 32-bit systems, assembly

language programming and the use of high-level languages. Basic input/output including parallel communications with and without handshaking and serial protocols. Hardware and software timing. Using interrupts and exceptions. Overview of single-chip microprocessors and controllers with an emphasis on the Motorola 68HC11. The internal structure and design of peripheral devices. Memory system design and analysis. The use and structure of development tools such as (cross) assemblers or compilers, monitor programs, simulators, emulators, etc. The lab work will consist of programming a small robot to detect and follow an optical path. (formerly ELE 538).

**COE 608 Computer Organization and Architecture**
Topics include: Basic structure of modern computers. Interaction between computer hardware and software at various levels. Computer hardware and technology. Performance evaluation and metrics. Instruction set design. Computer Arithmetic. Processor data path and control design for MIPS Processor. The laboratory work includes the design and implementation of 16 bit CPU using Altera Max+Plus II software and VDHL.

**COE 618 Object-Oriented Engineering System Analysis and Design**
This course deals with the analysis and design of complex engineering systems. In particular, students will be asked to create requirement specifications prior to the design and implementation of such engineering systems. Case studies from hardware and software development projects will be used to illustrate the design process. Development of expertise in analyzing, designing, implementing, and testing industrial-quality, reusable software and hardware systems. Project work include practice with an object-oriented programming language, and high-level object/library creation using HDL.

**ELE 635 Communication Systems**
This course studies basic principles of communication theory as applied to the transmission of information. The course topics include: baseband signal transmission, amplitude, phase and frequency modulation, modulated waveform generation and detection techniques, effects of noise in analog communication systems, frequency division multiplexing. Digital Signals: sampling theorem; reconstruction and aliasing, quantization and introduction to pulse code modulation.

**ELE 637 Energy Conversion**
Basic principles of operation of different types of machines and their control; magnetic circuit analysis, single-phase, and three-phase transformers, principles of electromechanical energy conversion, DC machines, three-phase induction motors, synchronous machines, introduction to solid-state motor controls and devices, transients and dynamics of machines, introduction to programmable logic controller (PLC), control of machine by PLC.

**ELE 639 Control Systems**

Introductory course in control theory: system modeling, simulation, analysis and controller design. Description of linear, time-invariant, continuous time systems, differential equations, transfer function representation, block diagrams and signal flows. System dynamic properties in time and frequency domains, performance specifications. Basic properties of feedback. Stability analysis: Routh-Hurwitz criterion, Root Locus method, Bode gain and phase margins, Nyquist criterion. Classical controller design in time and frequency domain: lead, lag, lead-lag compensation, rate feedback, PID controller.

**ELE 704: CMOS Integrated Analog Circuits**

This course deals with the analysis and design of CMOS analog integrated circuits with an emphasis on circuits for high-speed data and wireless communications. The course consists of three essential components: theory, laboratory, and project. The theoretical component consists of : characterization of analog integrated circuits in frequency and time domains; layout techniques for analog MOS devices; building blocks of CMOS analog integrated circuits and their characteristics particularly noise and high-frequency characteristics; voltage and current reference circuits; voltage operational amplifiers; current operational amplifiers; switched-capacitor circuits and their applications in telecommunications; voltage and current comparators; ring oscillators and voltage-controlled oscillators; advanced topics on design of low-voltage high-speed CMOS integrated circuits including impedance matching, bandwidth boosting techniques, low-voltage design techniques and voltage-mode versus current-mode designs. The laboratory component consists of design and simulation (i) a differential-input single-output CMOS voltage operational amplifier and (ii) a low-voltage differential-input differential-output CMOS current operational amplifier with given design specifications. Laboratories will be carried out using state-of-the-art computer-aided design (CAD) tools for integrated circuits. The third essential component of the course is the project. Students are required to complete a given or self-initiated design project on CMOS analog or mixed analog-digital integrated circuits with a professionally prepared project report.

**ELE 734 Low-Power Digital Integrated Circuits**

This course deals with the design of Digital CMOS integrated circuits. The course consists of three essential components: Theory, Laboratory, and project. Variety of design techniques, such as Static CMOS, Dynamic CMOS, and Transmission Gate are discussed in theory. These designs are studied on basic logic gates as well as combinational and sequential circuits. The lessons learned are applied to arithmetic building blocks such as adders, multipliers, and memory elements. A MOS transistor is studied using I-V equations, and the different areas of operations are modeled. The static (DC) are dynamic (transient) behaviors for an important building block, a CMOS inverter, are studied in depth.

**ELE 745 Digital Communication Systems**
This course provides a comprehensive introduction to basic principles and techniques of digital communication. Lecture topics include: sampling theory, baseband transmission, matched filter, intersymbol interference, digital modulation, coherent and non-coherent detections, etc. Laboratory work is based on simulations in Matlab.

**ELE 754 Power Electronics**
A course on microprocessor-controlled solid state converters. Major topics include: switching devices (SCR, MOSFET, IGBT, GTO, etc.), dc-dc switch mode converters, diode & thyristor rectifiers, current & voltage source inverters, industry applications and microprocessor programming techniques. Typical control schemes for these converters will also be discussed. Important concepts are illustrated with laboratory design projects. A 68HC11 microprocessor based MPP board will be used in the projects.

**ELE 792 Digital Signal Processing**
This course provides a comprehensive introduction to basic principles and applications of digital signal processing (DSP). Lecture topics include: representation and analysis of discrete-time signals and systems, z transform, discrete Fourier transform (DFT), fast Fourier transform (FFT), digital filter design techniques (FIR and IIR) and multi-rate signal processing. The laboratory component of the course reinforces the DSP fundamentals through design and implementation of real-time algorithms on DSP hardware and Matlab.

**ELE 846 Power Systems**
This course deals with the analysis of electrical power systems. Topics include: power system primary equipment modeling, network calculation, current and voltage relations of transmission lines, power flow studies, symmetrical faults, symmetrical components, unsymmetrical faults, power system protection, and power system stability. Introduction to ETAP (power system analysis software).