

Electrical Engineering Ph.D. Qualifying Examination

Guidelines for the Graduate Student

The Ph.D. Qualifying Examination (QE) in the Department of Electrical Engineering consists of an oral examination. The purpose of this QE is to assess your readiness to conduct research in your chosen field by testing your ability to apply what you have learned in classes to analyzing research literature. A student entering the Ph.D. program already having an M.S.E.E. must pass this exam within 3 long semesters, and a student entering without already having an M.S.E.E. within 4 long semesters. Admission to Ph.D. candidacy is based on two criteria: performance in the oral QE and GPA in graduate level organized courses. Each student has at most two attempts at this qualifying exam.

Oral Examination:

- You must declare intent to take the exam in the first three weeks of the semester using the "Application for the Doctoral Qualifying Examination" form. (Deadlines for application will be advertised to graduate students as early as possible each semester.) You must be registered for the semester in which you are taking the QE.
- Each student must choose one of the following research areas for the oral examination. (For each area there will be one QE committee of 3 faculty members + one alternate - appointed by the department chair.) The core knowledge topics that the student is expected to understand are listed below for each of the research areas.
 - a. **Communications** - Concepts in random processes and digital communications such as stationarity and independence, auto-correlation and cross-correlation functions, introduction to Markov Chain, linear systems with random inputs, spectral characteristics, low-pass equivalent representation of bandpass signals and systems, signaling schemes and performance of binary and M-ary modulated digital communications, MAP and ML detection, overall design considerations and performance evaluations of digital communications systems.
 - b. **Signal Processing** - Concepts in random processes, stationarity and independence, auto-correlation and cross-correlation functions, spectral characteristics, linear systems with random inputs, analysis of discrete time signals and systems, difference equations, Z-transform, Fourier transform, discrete Fourier transform, fast Fourier transform, analysis and design of digital filters.
 - c. **Digital Systems** - Combinational and sequential logic design, basic logic minimization and time analysis techniques, basic arithmetic circuits, design for testability (scan and built-in self-test), quantitative analysis and evaluation of computer systems, pipelining, memory hierarchy, serial/parallel I/O.
 - d. **VLSI Circuits and Systems** - MOS transistor characteristics, CMOS technology, analysis, design and layout of static CMOS gates, the method of logical effort, clocking and timing issues, flip-flop design, other CMOS technologies including dynamic logic, SRAM design, design of adders and multipliers.
 - e. **Analog and Mixed-Signal Circuits** - Models of active devices, single-stage amplifiers, differential amplifiers, current sources, current mirrors, active loads, voltage and current references, opamp design, frequency response, stability and compensation, two-stage amplifiers.

- f. **Devices and Device Fabrication** - Electromagnetic theory, principles of quantum physics, semiconductor physics, active devices, micro-electro-mechanical devices.
- g. **RF/Microwave** - Impedance matching, network theory, S-parameters, transmission line media (waveguide, coax, microstrip, stripline, coplanar waveguide, etc.), passive component design (power dividers, couplers, switches, attenuators, phase shifters, etc.), narrow band and broadband matching circuits, low noise amplifiers, noise figure, noise parameters, stability criteria, and linearity.
- h. **Optics** - Dielectric waveguides, waveguide modes, coupled-mode formalism, directional couplers, diffractive elements, switches, wavelength-tunable filters, polarization properties of devices and fibers, step and graded-index fibers, fiber measurements, fiber splices, fiber systems, polarized light; Jones and Mueller matrices; interference of polarized waves; interferometers, diffractive phenomena.
- i. **Control Systems** - Systems and control theory: linear systems: state space, transfer functions, stability, controllability, observability, and feedback; stability of nonlinear systems, Lyapunov stability; differential geometric tools, feedback linearization, input-output linearization, output injection, output tracking.
- j. **Biomedical Applications** - Anatomy and human physiology including: nervous system, muscular, circulatory and vascular, immune, and digestive systems. Modern molecular and cellular biology concepts including genes, protein structure and function, organization of cells and cellular trafficking.
- k. **An "Emerging Area" of EE** - A set of core topics based upon core knowledge learned in UTD MSEE core classes will be defined by the exam committee and given to the student at least 6 weeks in advance of the exam.

- The QE committee will be appointed by the Department as expeditiously as possible. It will consist of three (3) tenure track faculty in your general field of study. Your research advisor shall not serve on this committee.
- At least three (3) weeks prior to the examination date you will be assigned research papers (journal and/or conference proceedings articles) to study, analyze and present to an examining committee. The examining committee may choose to use up to 2 research papers rather than just a single paper in your general field of research.
- You will be given a set of instructions for preparing for the examination. These instructions will describe the format of the oral presentation, the field of study to be covered by questions and the expectations of the Department for successful completion of the examination. In particular:
 - You must demonstrate competency over core knowledge in your chosen research area (see above).
 - You must demonstrate the ability to understand the research article(s) chosen for the exam.
- You will present a concise overview of the paper(s) according the departmental instructions at the start of the oral examination period.
 - The presentation is to be less than 15-20 minutes in duration.
 - Key results from the paper – demonstrating understanding of those results.
 - Connection to core knowledge in area.
- After the presentation, the examination committee will ask questions related to the area core topics and the contents of the paper(s). The questions will probe your level of ability to read, understand, analyze and apply the results in those articles. Questions will also probe your ability to apply the area core topics to the subject of these articles.

Evaluation Procedure:

- The final evaluation will be based on two components:
 - The “average exam score”: Each committee member will grade your performance on a scale of 0 to 4. The scores will be averaged.
 - The “GPA score”: Your MSEE GPA or GPA in graduate level organized courses will be used as the “GPA score.”
- The final evaluation score shall be calculated by the examination committee chair as:
(average exam score)*2/3 + (GPA score)*1/3
- The final decision of pass, fail or conditional pass shall be communicated to you as expeditiously as possible by the Department Chair.