



**Electrical Engineering  
Engineering & Mines**

# **Graduate Student Guideline**

**Department of Electrical Engineering**

**College of Engineering and Mines**

**University of North Dakota**

**Updated August 2015**

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## 1. Introduction

### 1.1. Department of Electrical Engineering Mission Statement

To educate, inspire, and enhance the competitiveness of our graduates through integration of teaching and collaborative research focused on scientific innovation and discovery.

### 1.2. Department of Electrical Engineering Vision Statement

To be a global leader in education and research

### 1.3. Department of Electrical Engineering Program Educational Objectives

- Graduates successfully practice electrical engineering and related fields regionally, nationally, and internationally.
- Graduates are well-prepared in the fundamental concepts of electrical engineering and continuously pursue professional development.
- Graduates are skilled in communication and teamwork, capable of functioning effectively, responsibly and ethically in diverse and global work environments.
- Graduates succeed in further graduate and professional studies.

### 1.4. Areas of Study

The Department of Electrical Engineering (EE) offers graduate programs leading to either a Master of Science (M.S.) or a Master of Engineering (M.Engr.) degree. The M.S. degree is offered with both the thesis and non-thesis options. The M.Engr. degree is an engineering practice-oriented degree. The Department also offers combined programs, including a Bachelor of Science in Electrical Engineering (BSEE)/Master of Science in Electrical Engineering (M.S.E.E.) and a B.S.E.E./M. Engr. The intent of the combined programs is to allow qualified students to complete requirements for both degrees in one year beyond that required to receive the baccalaureate degree. Additionally, the department offers M.S. EE online and Ph.D. in Electrical Engineering.

### 1.5. **Graduate Faculty and Research Areas**

The three research clusters of the Department of Electrical Engineering are:

1. **Biomedical Engineering** (Brain, Cardiovascular, Biomedical Devices, Mobile Health),
2. **Energy** (Power Grid, Power Network, Data and Security), and
3. **Communication and Networking** (Smart Grid, Multifunctional Radar, Spectrum Sensing and Management, Big Data).

Details of research projects and information about each faculty can be found at the faculty webpages (<http://engineering.und.edu/electrical/faculty/>).

## 2. Graduate Programs of Study

The Department of Electrical Engineering offers a combined program, Master of Engineering, Master of Science (with thesis option), Master of Science (with no-thesis option), on-line Master of Science (with no-thesis option), and PhD in Electrical Engineering.

### 2.1. Combined Program

The intent of the combined programs is to allow qualified students to complete requirements for both degrees in one year beyond that required to receive the baccalaureate degree.

#### 2.1.1. Admission Requirements for B.S./M.S. or B.S./M.Engr. Degree

Admission requirements for the combined program are:

1. Students may apply for this program upon completion of 95 credits toward the bachelor's degree.
2. An overall undergraduate GPA of 3.0 at the time of admission.
3. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.
4. Students who have received a bachelor's degree or higher from the United States or English-speaking Canada are not required to submit the TOEFL.

#### 2.1.2. Degree Requirements

Students seeking the Master of Science or Master of Engineering degree through the Combined Degree program at the University of North Dakota must satisfy all requirements for both the B.S. and M.S. degree. A maximum of six credits of prior approved coursework can get double counted toward each of the two degrees. Double counted courses may not include required courses for the B.S.E.E. degree, but may include technical or electrical engineering elective coursework, preferably at the 500-level or above.

Degree requirements for the M.S. or M.Eng. degree will be those listed by the School of Graduate Studies as found in the graduate school catalog.

## **2.2. Master of Engineering (M.Eng.)**

### **2.2.1. Admission Requirements**

The applicant must meet the School of Graduate Studies' current minimum general admission requirements as published in the graduate catalog.

1. Bachelor of Science degree in Electrical Engineering or closely related field. Students holding B.S. degrees in other fields, e.g., physics, mathematics, and computer science, may be admitted to Provisional or Qualified status until undergraduate requirements in electrical engineering have been satisfied.
2. An overall undergraduate GPA of at least 2.5 or a GPA of at least 2.75 for the last two years.
3. Applicants holding degrees from non-ABET accredited programs/universities must submit scores from the General Test of the Graduate Record Examination.
4. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

### **2.2.2. Degree Requirements**

1. Course necessary for basic-level ABET accreditation. Normally, graduation from an ABET-accredited institution will satisfy this requirement.
2. A program of study must include the following:
  - A. A minimum of 30 semester credit hours.
  - B. Three to Six (3-6) semester credit hours of an approved design project (EE 595 Design Project).
  - C. Fifteen (15) semester credit hours of coursework at the 500 level or above (including the design project).
  - D. All major courses must be at the 400-level or above and approved for graduate credit.
3. An overall GPA of 2.75 or better for all coursework.
4. Complete the approved design project.
5. Pass a comprehensive written examination.

6. One peer reviewed manuscript (as first author, such as conference paper, journal paper or patent application) submitted with the consent of advisor.

### **2.3. Master's Degree - Thesis Option**

#### **2.3.1. Admission Requirements**

The applicant must meet the School of Graduate Studies' current minimum general admission requirements as published in the graduate catalog.

1. Bachelor of Science degree in Electrical Engineering or closely related field. Students holding B.S. degrees in other fields, e.g., physics, mathematics, and computer science, may be admitted to Provisional or Qualified status until selected undergraduate requirements in electrical engineering have been satisfied.
2. An overall undergraduate GPA of at least 2.75 or a GPA of at least 3.00 for the last two years.
3. Applicants holding degrees from non-ABET accredited programs/universities must submit scores from the General Test of the Graduate Record Examination.
4. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

#### **2.3.2. Degree Requirements**

1. A minimum of 30 semester credits, including credits granted for the thesis.
2. A minimum of 21 semester credits, including 6 thesis credits, must be in the major field of electrical engineering.
3. A minor field of study can be obtained by completing 9 semester credits from another department that offers a graduate program. A graduate faculty member from that department must serve on the thesis committee.
4. A cognate can be obtained by completing 9 semester credits from more than one department outside of electrical engineering, or from a single department that does not offer a graduate program.
5. At least one-half of the credits must be at or above the 500-level.
6. A maximum of one-fourth (usually 8-9 semester credits) of the credit hours required for the degree may be transferred from another institution.



7. Completion of a research project and its presentation in a thesis.
8. An overall GPA of 3.00 or better in all coursework.
9. The thesis course (EE 998) can be between 6-9 credits with approval of the thesis committee.
10. At least one credit of seminar class (EE 570) is mandatory for each MS students (thesis option). Students can repeat this class to the maximum number of three times.
11. At least two peer-reviewed conference, journal, or patent applications (as the first author) submitted with the consent of student's advisor before the time of defense.

## **2.4. Master's Degree - No-thesis Option**

### **2.4.1. Admission Requirements**

The applicant must meet the School of Graduate Studies' current minimum general admission requirements as published in the graduate catalog. M.S.E.E with no-thesis option can be offered in two modes of campus or online.

1. Bachelor of Science degree in Electrical Engineering or closely related field. Students holding B.S. degrees in other fields, e.g., physics, mathematics, and computer science, may be admitted to Provisional or Qualified status until selected undergraduate requirements in electrical engineering have been satisfied.
2. An overall undergraduate GPA of at least 2.75 or a GPA of at least 3.00 for the last two years.
3. Applicants holding degrees from non-ABET accredited programs/ universities must submit scores from the General Test of the Graduate Record Examination.
4. Satisfy the School of Graduate Studies' English Language Proficiency requirements as published in the graduate catalog.

### **2.4.2. Degree Requirements**

1. Completion of at least 32 semester credits, including credits required for the major.
2. A minimum of 2 credits of Independent Study
3. At least one-half of the credits must be at or above the 500-level.
4. A maximum of one-fourth (usually 8-9 semester credits) of the credit hours required for the degree may be transferred from another institution.

5. Preparation of a written Independent Study report approved by the faculty advisor.
6. Comprehensive final examination.
7. An overall GPA of 3.00 or better in all coursework.
8. At least one peer-reviewed manuscript (conference, journal, or patent application as the first author) submitted with the consent of student's advisor.

## **2.5. Doctor of Philosophy Degree**

The Doctor of Philosophy in Electrical Engineering program provides a student with specialized training customized to meet his or her specific interests and goals. Faculty advisors work with each student to structure a graduate program consisting of traditional engineering study, complementary multidisciplinary studies, strong interaction between fellow engineering students, and high quality research. The program is based upon the research strengths of faculty, and includes studies in the major engineering disciplines.

The program includes a significant research component characterized by substantial interaction between the student and their adviser. Research topics are determined based upon the mutual interest of the student and research adviser. Students develop a strong research methodology and apply this research method to a specific engineering problem as directed by their adviser. Student's attendance is required at a weekly seminar. This seminar is used to enhance the research methodology, by allowing students to present their research during various stages of development.

### **2.5.1. Mission Statement and Program Goals**

The program recognizes that effective researchers should have extensive expertise in Electrical Engineering coupled with a familiarity and awareness of related research needs and the context for applying that expertise. A principal goal of the program is to train electrical engineering Ph.D. researchers for careers that focus on the invention and development of new technologies and advances for the 21st Century and beyond. Activities to develop professional and personal skills are intended through a multidisciplinary emphasis to enable participants to:

1. understand the ethical, political, and economic impacts of their research developments and policies; and
2. improve their ability to communicate about complex technical subjects in both professional and general settings.

**Goal 1:** Graduates will have a depth of knowledge in electrical engineering accompanied by a breadth of knowledge in related areas to achieve their specific goals and objectives.

**Goal 2:** Graduates will be proficient researchers, i.e., they will have the skills required to formulate, assess and document a hypothesis.

**Goal 3:** Graduates will be well prepared for advanced professional practice, for teaching, and for careers in research and creative activity in electrical engineering or a related field.

### **2.5.2. Admission Requirements**

1. A baccalaureate degree in an engineering discipline with a GPA of 3.3 or higher or a Master of Science degree in an engineering discipline with a GPA of 3.0.
2. Satisfy the Graduate School's English Language Proficiency requirements as published in the Graduate Catalog.
3. In addition to meeting the general provisions in the UND graduate catalog and the minimum requirements in items 1-2 above, candidates are assessed using a holistic process that considers Student's Record of Publications, GRE test scores (for students who are applying with a B.S. engineering degree from a non-ABET accredited program), transcripts of previous college work, relevant research and work experience, letters of recommendation, research interests, and English language skills. Students must specify a track on their admission form to facilitate this evaluation.
4. A student holding a non-engineering degree or who does not meet the minimum requirements in items 1-2 above may apply to one of the Master of Science degree programs in the College of Engineering and Mines. Students successfully completing a UND M.S. engineering degree will be considered to satisfy the requirements of items 1-2 above; however, these students shall still be subject to the holistic evaluation process described in item 3 with the exception that new GRE test scores will not be required.

5. Students admitted to an engineering M.S.E.E. program but meeting the minimum requirements in items 1-2 above, may after one calendar year, and upon the recommendation of his/her advisory committee, request to by-pass the master's degree and work directly toward the Ph.D. degree. The recommendation of the advisory committee shall be brought to a vote by the program graduate committee relevant to the degree track requested by the student. A minimum of one week before such a meeting, the program graduate committee shall be notified and provided with the student's updated file which shall consist of the materials used for application into the M.S.E.E. program, a transcript of all academic work completed at UND, and any additional materials the student wishes to have considered. If the recommendation is approved by the relevant graduate committee, the student will be given the qualifying exam. Passing this exam will advance the student to Approved Status in the Doctoral Program in Electrical Engineering.

### **2.5.3. Residence Requirements**

The purpose of residence requirements is to provide an opportunity for a sustained and concentrated intellectual effort, to provide for immersion in an academic research environment, and to permit extensive interaction with fellow students and faculty of the Electrical Engineering Department. Within the first two years of graduate work at UND, at least two consecutive semesters must be completed in residence. During residency, a student must be registered for at least nine credits in a semester, or be a graduate research or teaching assistant taking the appropriate credits to qualify as a full-time student. The remainder of the credits required for a degree can be completed in a manner to accommodate the student's fiscal, family, job related, and other constraints with the consent of the student's adviser. The program of study must be completed within the seven-year period normally allowed for graduate programs. Under special circumstances, the student in conjunction with his/her advisory committee and the Electrical Engineering Graduate Committee, can petition the Dean of the Graduate School for variances in this policy.

### **2.5.4. Degree Requirements**

Students seeking the Doctor of Philosophy degree at the University of North Dakota must satisfy all general requirements set forth by the Graduate School as well as particular requirements set forth by the Electrical Engineering Doctoral Program.

The following requirements are in addition to the UND graduate school general requirements for the Ph.D.:

1. Completion of 90 semester credits beyond the baccalaureate degree
2. Maintenance of at least a 3.0 GPA for all classes completed as a graduate student.
3. Scholarly Tools: Proficiency in mathematics demonstrated by completing nine approved credits of mathematics intensive coursework (equivalent to UND 400-level or higher courses) with a grade of B or better which must include at least one course in numerical analysis. Scholarly tools courses taken for graduate credit after a student has enrolled in a graduate program at UND may be counted to fulfill requirements listed in Item 5 below.
4. A maximum of 30 credit hours can be transferred from a master's program.
5. A minimum of 30 credit hours must be doctoral research and dissertation.
6. Exactly 3 credit hours of the EE 570-Graduate Seminar must be taken.
7. A minimum of 39 credit hours of coursework are required (up to 21 credit hours of coursework may be transferred from a master's program in fulfilling this requirement subject to the credit transfer limits described in the general section of this graduate catalog). The coursework shall include a minimum of 27 credit hours of Electrical Engineering (or relevance courses with the consent of advisor) coursework selected from the approved list of courses. Equivalent graduate level coursework may be transferred from a master's program.
8. Successful completion of a qualifying examination, taken no earlier than the end of their first year in residence and no later than the end of their second year of residence. The qualifying examination includes the following three sections.

## **Section I**

It will cover four general areas of their selected engineering track. Selection of the four general areas for this examination shall require the approval of the candidate's faculty adviser and the track-specific Ph.D. Graduate Director. Three results for each of the four sections of the examination can be obtained: 1) pass; 2) provisional pass; and 3) fail. Candidates obtaining a result of "provisional pass" for any section of the exam will be required to remediate the topical area in which the provisional pass was received in accordance to stipulations specified by the examiner, with approval of the track-specific Graduate Director. Candidates who fail one or more sections of the exam will be allowed one opportunity to repeat that section of the exam. The reexamination must take place no later than 13 months after the initial examination attempt. A direct admit student who fails an exam a second time may request to be reclassified as a master's student and complete a track-appropriate Master of Science degree and then reapply to the Doctoral program.

## **Section II**

A detailed written doctoral research proposal must be submitted to the committee. The proposal should cover:

- A) a literature review of the relevant field of research related to the project
- B) proposed methods
- C) preliminary results (simulation or experiment)
- D) the objectives of the proposed project, and
- E) tasks and the timeline of the proposed research in a Gantt chart.

The report should be reviewed and approved by the student advisor. Then, at least three weeks prior to the next step, the report should be distributed to the student committee members for their review and grading.

Each of the above (A-E) components will be evaluated and graded (0 to 20). To pass the written exam, student should earn a minimum of 16/20 in each category. All grades from

student committee members will be averaged to determine a grade in each category.

If the report earns a passing grade a date can be scheduled for an oral presentation (i.e., Section III). If failed, student has the opportunity to revise and resubmit the report to the committee for re-evaluation.

### **Section III**

An oral comprehensive examination should be presented to the committee on the research topics described in the above section (II-A to II-E). Three results for the oral exam can be obtained: 1) pass; 2) provisional pass; and 3) fail. Candidates obtaining a result of “provisional pass” will be allowed to Advance to Candidacy status after completion of stipulations specified by the examining committee plus obtaining a passing result on a retest for the portion of the exam covered by the stipulations. Candidates who fail the exam will be allowed one opportunity to repeat the exam in less than 6 months as specified by the student committee. Student who fails an exam a second time may request to be reclassified as a master’s student and complete a track-appropriate Master of Science degree and then reapply to the Doctoral program.

9. After successful completion of the written research proposal and oral presentation, an annual oral progress report should be presented to the committee. A part of these presentations will include details on the dissertation research progress and plan. Any deviation from the approved research objectives as stated and documented in the research proposal must be approved and justified by the committee.
10. A candidate for the degree must complete the original basic research investigation as documented in the research proposal. Each candidate will complete the research investigation to the satisfaction of the research adviser and the advisory committee and will prepare a written dissertation covering the research. The project must represent an original and independent investigation by the student. It is expected that the results of the research will be submitted for publication in refereed research journals. The candidate will submit the dissertation to the examining committee at least four weeks

prior to defense date. The examining committee consists the PhD committee and an external examiner from outside the University. The external examiner is selected by the department's graduate committee from a list of three candidates proposed by the advisor. The external examiner should not have any common publication with the student's advisor or student and can be from academia or industry with a expertise relevant to the student's research. The student and advisor should not contact the external examiner directly before or after.

11. The candidate must present and successfully defend the dissertation at the final examination (see School of Graduate Studies requirements). Four results of the examination can be obtained: 1) pass; 2) minor revision 3) major revision and 4) fail. For minor revisions there is no need for another defense session and upon revising the dissertation the examining committee can pass the student. For major revisions the student is asked to fundamentally revise the methodologies and schedule another defense session. If failed, the student will not be able to obtain a PhD degree and may request to be reclassified as a master's student and complete a Master of Science degree.
12. At least two peer reviewed ISI (Institute for Scientific Information) journals (as the first author) and two peer reviewed conference papers (as the first author) submitted with the consent of advisor.

### 3. List of Acceptable Courses

#### 3.1. Undergraduate Courses for Graduate Credit

- **EE 411. Communications Engineering. 3 Credits.**

Mathematical definition of random and deterministic signals and a study of various modulation systems. Prerequisite: EE 314.

- **EE 423. Power Systems I. 3 Credits.**

Electric power systems operation, control and economic analysis. Prerequisite: EE 313.

- **EE 428. Robotics Fundamentals. 3 Credits.**



Fundamentals of robotic systems: modeling, analysis, design, planning, and control. The project provides hands-on experience with robotic systems. Prerequisite: MATH 266 or consent of instructor.

- **EE 430. Introduction to Antenna Engineering. 3 Credits.**

Review of vector analysis and Maxwell's equations, wave propagation in unbounded regions, reflection and refraction of waves, fundamental antenna concepts, wire-and aperture-type antennas, wave and antenna polarization, antenna measurements, and computer-aided analysis. Prerequisite: EE 409 or consent of instructor.

- **EE 434. Microwave Engineering. 3 Credits.**

Review of transmission lines and plane waves, analysis of microwave networks and components using scattering matrices, analysis of periodic structures, transmission and cavity type filters, high frequency effects, microwave oscillators, amplifiers, and microwave measurement techniques. Prerequisite: EE 409 or consent of instructor.

- **EE 451. Computer Hardware Organization. 3 Credits.**

The study of complete computer systems including digital hardware interconnection and organization and various operation and control methods necessary for realizing digital computers and analog systems. Prerequisite: EE 201 and EE 304; or consent of instructor.

- **EE 456. Digital Image Processing. 3 Credits.**

Digital image retrieval, modification, enhancement, restoration, and storage. Image transformation and computer vision. The associated laboratory provides hands-on experiences. Prerequisite: EE 304 and EE 314.

### **3.2. Graduate Courses**

- **EE 503. Statistical Communications Theory and Signal Processing I. 3 Credits.**

Theory of time series analysis of random signals as applied to signal processing is emphasized. Prerequisite: EE 411 or consent of instructor.

- **EE 504. Statistical Communications Theory and Signal Processing II. 3 Credits.**

Advanced methods of signal detection including linear parameter estimation and non-linear estimation of parameters. Detection of signals and estimation of signal parameters from a probability point of view will be emphasized.

- **EE 505. Control Systems II. 3 Credits.**

Advanced topics in control systems including nonlinear systems, robust control, optimal control, and pole placement techniques; selective topics from the state of the art. Prerequisite: EE 405.

- **EE 506. Digital Control Systems. 3 Credits.**

Digital systems representation, analysis and simulation; Z-transform; digital controllers design and realization; microprocessor based controllers. Prerequisite: EE 405.

- **EE 507. Spacecraft Systems Engineering. 3 Credits.**

Space environment, dynamics of spacecraft, celestial mechanics, mission planning, and systems engineering methodology.

- **EE 508. Intelligent Decision Systems. 3 Credits.**

Systems and networks will be designed to work in an uncertain environment. Systems will be optimized using Neural Networks and Fuzzy Logic concepts. Prerequisite: EE 314 or consent of instructor.

- **EE 509. Signal Integrity. 3 Credits.**

Fundamental concepts of signal integrity are presented. Topics include propagation of digital signals, electrical noise, and system timing. Prerequisite: EE 409 or consent of instructor.

- **EE 511. Power Electronics. 3 Credits.**

Principles of power electronics switching control circuits. Including AC/DC, DC/DC, DC/AC converters, their harmonics and filtering techniques, and their application in switching power supplies, electric drives,

renewable energy systems, etc. Prerequisite: EE 321 or consent of instructor.

- **EE 512. Wireless Communications. 3 Credits.**

Prerequisite: EE 411 or consent of instructor.

- **EE 519. Digital Computer Logic. 3 Credits.**

Logic design analysis of digital computers with some applications. Prerequisite: EE 451 or consent of instructor.

- **EE 520. Electronic Computing Systems. 3 Credits.**

Design of bit slice computers; simulation of computers' special purpose controller design; advanced microprocessor design and use. Prerequisite: EE 201 and EE 421.

- **EE 521. Digital Signal Processing. 3 Credits.**

Modern methods of digital signal processing will be studied. Techniques that will be used include the recursive and nonrecursive discrete-time filters and the Fourier Transform. Prerequisite: EE 314.

- **EE 522. Renewable Energy Systems. 3 Credits.**

This course will provide engineering students with an understanding of the principles of renewable energy conversion systems. Emphasis is on wind, photo-voltaic, hydrogen fuel, and fuel cell energy conversion and storage systems, along with their associated design and control issues.

- **EE 523. Power Systems II. 3 Credits.**

Electric power systems analysis and control. Power flow; system response and stability; voltage and frequency control; computer methods in system analysis. Prerequisite: EE 423.

- **EE 524. Application Specific Integrated Circuit (ASIC) Design. 3 Credits.**

To gain an historic perspective of ASIC Design. To familiarize students with the existing IC technology and their attributes. To recognize basic fabrication process, layout, circuit extraction and performance analysis.

To understand CAD tools, hardware, systems engineering, and operational issues. Prerequisite: EE 421 or consent of instructor.

- **EE 525. Electromagnetic Fields. 3 Credits.**

Static electric and magnetic fields, field mapping, and applications to transmission lines, wave-guides, and antennas. Prerequisite: EE 316.

- **EE 530. Phased Array Antennas. 3 Credits.**

Basic antenna and array characteristics, pattern synthesis techniques, analysis and design of radiating elements and feed networks, mutual coupling and array error analysis, adaptive arrays. Prerequisite: Consent of instructor.

- **EE 532. Antenna Theory. 3 Credits.**

Physical principles underlying antenna behavior and design as applied to antennas. Prerequisite: EE 316 or consent of instructor.

- **EE 536. Optical Fiber Communications. 3 Credits.**

Propagation in optical fibers, optical receivers, amplifiers, detectors, sources, transmission links, noise consideration, optical fiber communication systems, applications and future developments. Prerequisite: EE 434 or consent of instructor.

- **EE 537. Graduate Cooperative Education. 3 Credits.**

A practical research experience with an employer closely associated with the student's academic area. A written report which includes a literature survey and research findings and an oral presentation are required. Prerequisites: Approved status, 3.0 GPA, completed a minimum of 9 credits of program study, and approval of the department.

- **EE 539. Electromagnetic Compatibility. 3 Credits.**

Prerequisite: EE 409 or consent of instructor.

- **EE 540. Computer Networks Communications. 3 Credits.**

This course introduces fundamental concepts in the design and implementation of computer networks and their communication

protocols, including the OSI model and TCP/IP protocol suite. Prerequisite: Consent of the instructor.

- **EE 545. Introduction to Biomedical Engineering. 3 Credits.**

This course introduces biomedical engineering and several systems of the human physiology. Signals of biological origin obtained from these systems, biosensors, transducers and bioelectrodes used to acquire such signals, along with medical quality amplifiers for measuring biopotentials, are discussed. Prerequisite: EE 314, EE 421 or consent of instructor.

- **EE 550. Biomedical Instrumentation. 3 Credits.**

Prerequisite: EE 314, EE 316, EE 421 or consent of instructor.

- **EE 552. Advanced Embedded Systems Design. 3 Credits.**

This course provides students with cutting-edge techniques in the design and implementation of advanced embedded systems that involve analog/digital conversion, interrupts, timers, CCP modules, and parallel/serial communications. Prerequisite: EE 452 or consent of instructor.

- **EE 560. Engineering Computation. 3 Credits.**

Development and application of optimization techniques in practical problems encountered in electrical engineering, Downhill and probabilistic optimization techniques, Modeling of complex systems by partial differential equations and their numerical solution by finite difference and finite element methods. Prerequisite: Consent of instructor.

- **EE 570. Seminar. 1 Credit.**

The purpose of the course is to practice communication skills in writing papers and preparing presentations. Open to qualified advanced undergraduate students and graduates. Repeatable to 3 credits. On demand.

- **EE 590. Advanced Electrical Engineering Problems. 1-4 Credits.**

Students work under the supervision of a member of the staff. A written report is required. Repeatable for credit. Prerequisites: Open by permission to graduate students and qualified seniors.

- **EE 595. Design Project. 3-6 Credits.**

A three to six credit course of engineering design experience involving individual effort and a formal written report. Repeatable to 6 credits. Prerequisites: Restricted to Master of Engineering student candidates and subject to approval by the student's advisor.

- **EE 996. Continuing Enrollment. 1-12 Credits.**

- **EE 997. Independent Study. 2 Credits.**

- **EE 998. Thesis. 1-6 Credits.**

### **3.3. Ph.D. Courses**

In addition to above courses, the following courses can be selected for the Ph.D. program.

- **ENGR 590. Special Topics in Engineering. 1-6 Credits.**

Investigations of special topics in energy engineering dictated by students and faculty interests. Repeatable. Prerequisite: Consent of instructor.

- **ENGR 599. Doctoral Research. 1-15 Credits.**

Repeatable to 60 credits.

- **ENGR 996. Continuing Enrollment. 1-12 Credits.**

- **ENGR 998. Thesis. 1-9 Credits.**

Repeatable to 9 credits.

- **ENGR 999. Dissertation. 1-18 Credits.**

Repeatable to 18 credits.

## 4. Policies and Procedures

### 4.1. Communication with the School of Graduate Studies

All forms and correspondence discussed in the following sections should be communicated with the School of Graduate Studies only through the Graduate Program Director.

### 4.2. Orientation

After student arrives at UND, he/she should contact the Graduate Program Director and arrange an Orientation meeting with the Department Chair, Graduate Program Director and Advisor. At this meeting, policies and procedures will be explained to the student and the student has a chance to ask questions related to his/her program of study.

### 4.3. Research Advisor and Project Selection

After arriving on campus, all new graduate students are expected to meet with their advisors to discuss their research project. For graduate students who are undecided about their research areas and/or assigned Graduate Program Director as the temporary advisor, they are expected to meet with all EE graduate faculty members and have a maximum of one semester to decide about their research area and their advisor.

### 4.4. Appointment of Advisory Committee Members

The advisory committee of the student should be appointed within the first year. The advisory committee members should have experience in the research area related to the student's research topic and they will be selected by the advisor with agreement of the student. If there is any disagreement between the advisor and student, the case will be submitted to the Graduate Program Director in writing to be discussed in the Department Graduate Committee. This committee will decide about the committee members. The "New Committee or Change to Advisor or Committee" form from the School of Graduate Studies website (<http://graduateschool.und.edu/graduate-students/current/forms.cfm>) should be downloaded and completed. The form should be submitted to the School of Graduate Studies by the Graduate Program Director.

#### **4.5. Change of Advisor or Advisory Committee Members**

Student may request to change his/her advisor and/or a committee member after submitting a written request to the Graduate Program Director to be discussed in the Department Graduate Committee. The change can be made if the Department Graduate Committee approves this change. In addition, in the case of change of advisor, a meeting consists of the student, old advisor, new advisor (if known), the Graduate Program Director, and the Department Chair may be scheduled to discuss the reason for the change. The “New Committee or Change to Advisor or Committee” form from the School of Graduate Studies website (<http://graduateschool.und.edu/graduate-students/current/forms.cfm>) should be downloaded and completed. The form should be submitted to the School of Graduate Studies by the Graduate Program Director.

#### **4.6. Readmission and Change of Program**

At some point during graduate study, students may discover that their interests have changed. When this happens, there are procedures in place to help them change their program to fit their new objectives. If a student decides to be readmitted or change the program, a written request should be submitted to the Graduate Program Director to be discussed and evaluated in the Department Graduate Committee. The committee may arrange meetings with student and his/her advisor to decide if the request for change is approved or not.

#### **4.7. Course Registration**

To register for any class, student should complete “Advising Form” (available in the EE Graduate Student website) completed and necessary signatures hold be obtained.

#### **4.8. Annual Progress Evaluation**

The Electrical Engineering Department has required the annual progress evaluation for the annual evaluation of all students enrolled in M.S. and Ph.D. programs. This evaluation lists students’ milestones to date in the program and a description of coursework, research, and professional activities during the previous year. This form is available in the EE Graduate Student website and should be completed and signed by all graduate student committee members and submitted to the Graduate Program Director electronically by June 1 each academic year. Note that



not completing and submitting this academic progress report by June 1 will place the student in the “Unsatisfactory” status for that academic year. For PhD students, this written report is different from the annual oral presentation to the PhD committee after the completion of the PhD qualifying exam.

#### **4.9. Probation Policies**

Students whose academic performance is unsatisfactory or who are not meeting program requirements are placed on academic probation. Students on academic probation are subject to disqualification. Student with “Unsatisfactory” status will not receive GTA, GRA, tuition waivers, or any other financial support for the following year(s) till the status is changed to “Satisfactory.”

#### **4.10. Graduate Teaching Assistantship (GTA) and Graduate Research Assistantship (GRA)**

Graduate students admitted with regular status may apply for teaching or research assistantships. International students seeking teaching assistantships must demonstrate proficiency in spoken English.

Because there are many more applicants than positions available, there will be competition for the GTA and GRA positions. Applicants who are fully qualified are judged primarily upon grade point average, recommendations by faculty members, and English speaking scores. Preference is usually given to PhD students, particularly those who have passed the Qualifying Examination. Graduate assistants may receive a salary, an out-of-state tuition waiver, and a portion of in-state registration fees.

Research assistantships are awarded by the individual faculty members. Those students desiring research assistantships should review the faculty areas of interest (as available on the department web pages) and make contact with the appropriate professors. In addition to a stipend, graduate assistants working 50% (20 hours per week) receive waivers of both resident and non-resident tuitions.

No GTA will be awarded to MS students after 2 years or 30 credits in the program of study whatever happens first and to PhD students after 4.5 years or after 90 credits in the program of study (including all transfer credits) whatever happens first.

GTA position will be awarded and continued based on the availability of fund and student performance in both their research and GTA related works. The “GTA Evaluation Form” (available in the EE Graduate Student website) should be completed and submitted by all GTAs to the Graduate Program Director electronically at the end of each semester. No student may be assigned to more than total of 10 hours per week (quarter-time) GTA offered from EE department and all other departments.

#### **4.11. Co-op/ Internship**

In the UND course catalog, the co-op course is defined as follows:

*EE 537. Graduate Cooperative Education. 3 Credits. A practical research experience with an employer closely associated with the student's academic area. A written report which includes a literature survey and research findings and an oral presentation are required. Prerequisites: Approved status, 3.0 GPA, completed a minimum of 12 credits of program study, and approval of the department.*

The “Electrical Engineering Co-op Application Form” (available in the EE Graduate Student website) should be completed and submitted by the student to the Graduate Program Director electronically to be discussed in the Department Graduate Committee. The statement and approval of advisor is very important in this process. The last part of the prerequisite, i.e., “approval of department” is determined by the student application considering the following factors:

- The co-op course cannot be repeated and be less than 3 credits.
- The co-op application should be submitted at least one month prior to the start date.
- To spend a maximum of 3 months for MS students and 6 months for PhD students during the co-op for their program of study.
- To complete at least 1 full-time semester (for MS students) and 2 full-time semesters (for PhD students) of study prior to a work term.
- To complete a minimum of 2 graduate courses (for MS students) and 4 graduate courses (for PhD students), excluding EE 590.
- To obtain and keep health insurance during the co-op.

- To commit in writing a report and making a department presentation after returning from co-op related to the co-op experience.
- To have an official letter from the employer with period of the co-op (start and end dates), name and contact information of supervisor, and description of the work to be performed for the co-op program (to be attached to the application form).
- To have Program of Study approved by the UND School of Graduate Studies (to be attached to the application form)
- To demonstrate a close relationship between the work described by the employer and approved graduate research topic. This relationship should be justified in the application form and be approved by the student's advisor.
- This approval is based on the student's annual evaluations and satisfactory academic progress.
- The faculty advisor should be involved in the student's work to assist the student to develop a project that reflects that work experience.

The Department Graduate Committee will approve one of the following three cases:

- Co-op is approved with tuition waivers.
- Co-op is approved without tuition waivers.
- Co-op is rejected as a part of the student's program.

Note that violating department's regulations may affect the student status during this period. Students who hold GRA or GTA assistantships must be aware of the start and end dates of their duties while making co-op plans. Students are not permitted to keep their assistantship and be on co-op at the same time. Students who arrange co-ops that conflict with their assistantship start and/or end dates will NOT be appointed for that semester. The assistantship will be terminated and the tuition waivers cancelled for students who leave for a co-op after the semester has begun. The student will be liable for all fees covered by the tuition waivers at the appropriate rate. Students returning from a co-op after the semester has started will not be reappointed to the assistantship until the beginning of the following semester.

#### **4.12. Tuition Waivers**

The Electrical Engineering Department may award students tuition waivers. This will be awarded and continued based on the availability of funds and student performance.

#### **4.13. Mentoring**

The following guidelines are provided to outline the mentoring roles to guide the relationship between faculty and graduate students. Faculty and graduate students must realize that, while the major professor will be the primary mentor during a student's career at UND, program faculty other than the major professor may perform many of the mentoring "functions" defined here. An important result to this recognition is that faculty members must realize that much of their interaction with students has an important mentoring component to it. Graduate students also have responsibilities to ensure successful mentoring and these are also indicated in this section.

Faculty has a responsibility to mentor graduate students. Mentoring has been defined as:

- Providing a clear map of program requirements from the beginning, making clear the nature of the coursework requirements and expectations examination, and defining a timeline for their completion.
- Providing clear guidelines for starting and finishing dissertation or thesis work, including encouraging the timely initiation of the dissertation or thesis research.
- Evaluating clearly the strengths and weaknesses of the student's research.
- Encouraging an open exchange of ideas, including pursuit of the student's ideas.
- Providing and discussing clear criteria for authorship of collaborative research.
- Being aware of student's research needs and providing assistance in obtaining required resources.
- Providing guidance and serving as a role model for upholding the highest ethical standards.
- Treating students respectfully.
- Encouraging and critiquing oral and written presentations.

As partners in the mentoring relationship, graduate students have responsibilities. As mentees, students should:

- Recognize that their mentoring needs must respect their mentor's other responsibilities and time commitments.
- Maintain and seek regular communication with their mentors, especially their major professor.

#### **4.14. Research Laboratory Space**

University laboratories are provided to serve the instructional and research missions of the University. The authorization to access to the laboratories and equipment are designated by the EE Department Chair. Any person who believes that one or more persons are using any University laboratory without appropriate authorization shall report the matter promptly to the EE Chair. The department Chair's written authorization shall specify:

- the particular laboratory,
- the duration of the authorization, and
- any special terms or conditions of use.

Graduate students may be assigned a space in their advisor's research laboratory. They are responsible for cleaning their own area. Food and drinks are not allowed to be placed close to computers and equipment. The student will be responsible for any damage caused by ignoring this regulation. If any student would like to listen to audio file, a headphone should be used to avoid disturbing others. Non-research-related conversations and long phone calls should be taken outside the research labs. No equipment/computer/cable/book/manual can be moved outside of the research lab without approval of the student's advisor.

#### **4.15. Computer Usage**

Students should only use the software installed and approved by the UND. No software should be downloaded and installed by student unless it is approved by the student advisor. Computer and Network Usage based on the NDUS procedure can be found at: <http://www.ndus.edu/makers/procedures/ndus/default.asp?PID=301&SID=62#5.10>

#### **4.16. Research Work Dissemination, Publication, Communication**

Graduate students should inform their advisor about their communications (e.g., emails, letters, inquiries, applications, paper submission, etc. ) related to their research or lab research activities before contacting any body outside their research laboratory. No student is allowed to submit, publish, or contribute in any paper without consent of the advisor. If no UND facilities (e.g., space, software, hardware, ...) is used, no idea generated at UND is going to be disclosed, and the student is not going to use the UND affiliation, student may submit the work without advisor's permission.

If a paper is going to be submitted as the result of a course project and the student who is submitting the paper has advisor who is not the course instructor, the student's advisor should be informed and agreement should be reached before paper submission.

#### **4.17. Seminars**

Graduate students are expected to participate actively in the department seminars. Consistent contribution to and attendance in department seminars would affect student's priority to get GTA and other assistantships.

#### **4.18. Travel Fund Request**

To help students to attend and present their work, the department may support students by a travel fund subject to the fund availability. The "Department of Electrical Engineering Student Travel Fund Application Form" (available in the EE Graduate Student website) should be completed and submitted by student to the Graduate Program Director electronically before the event. If a fund is awarded to any student, the reimbursement will happen only after the event providing the original receipts. Note that no "Per Diem" can be paid from this fund and the fund will be awarded to only one student per paper. This fund cannot be used to pay any expense if an EE student shared the expense with non EE student (e.g., driving the same car, sharing the same room, etc.). No EE student will be reimbursed for the expense paid for any other student (EE or non-EE). Travel award is limited to one travel per year per student unless there is special circumstances with the Department Chair approval. The fund will be available to students only if students show evidence that they have applied to the following three sources:

1. R&D
2. Intecolligate
3. Graduate School (only for PhD students).

#### **4.19. Vacation and Leave of Absence**

Graduate students who intend to leave his/her reach lab more than one week, should inform their advisor at least one month before the leave date. The leave should be approved by student's advisor. During this period, student is not eligible for any finical aids.

#### **4.20. Preparation for Thesis/Dissertation Defense**

With approval of the student's advisor, after student decides to prepare for thesis (or dissertation) defense, the student should complete the "Notice of Master's Thesis Defense" (or "Doctoral Notice of Defense") and "Preliminary Approval of Thesis" (or "Preliminary Approval of Dissertation") and submit them through the Department Graduate Director the School of Graduate Studies. The forms are available at the School of Graduate Studies website (<http://graduateschool.und.edu/graduate-students/current/forms.cfm>).

#### **4.21. Oral Thesis/Dissertation Defense Announcement**

Students should submit his/her thesis title, abstract, and number of published paper resulted form his/her research to the Graduate Program Director to be announced in the department. This information should be submitted with the forms mentioned in the above section at least one week prior to the defense date. The thesis needs to be submitted to the examining committee at least three weeks before the defense day.

#### **4.22. Oral Thesis/Dissertation Defense Session Format**

At the time and location announced for the thesis/dissertation defense, the student should present the result of his/her research. At this session, the student's advisor should introduce the student with a short background, announce the student advisory committee, and explain to all audience that the format of the defense is as follows:

- a) The whole defense session including the presentation, Q&A, and the committee discussion should be administrated by the Department Chair or the Graduate Program Director (or someone assigned by the Department Chair).
- b) MS student must present his/her work in maximum of 30 minutes.
- c) PhD student must present his/her work in maximum of 40 minutes.
- d) No questions should be asked during the presentation.
- e) After student's presentation there will be normally three rounds of public questions. In the first two rounds, the advisory committee and the advisor (starting with external member, if any) will ask questions and at the final round, audience will have a chance to ask questions from the student.
- f) After three round of questions the student and audience are asked to leave the room and the examining committee will discuss the performance of the student.
- g) Upon the agreement of the committee, the chair of the session will ask the student to enter to the room to be informed about the committee's decision.

#### **4.23. Commencement**

Each year the University of North Dakota confers degrees of all levels on Commencement Day. Graduation is a time to salute academic excellence and personal achievement, as well as honoring old traditions and embracing new opportunities. The Commencement Ceremony is open to families and the general public, and honors each graduate individually for his/her achievements. All commencement information can be found at: <http://und.edu/student-affairs/commencement/>.

#### **4.24. Exit Interview/Survey**

After successful thesis/dissertation defense, graduate students should arrange a meeting with the Department Chair and Graduate Program Director to conduct an exit interview and they should complete an exit survey. Students must submit electronic copy of the thesis/dissertation report, final defense presentation slides, and all publications (posters and conference/journal papers) to the department Chair to be archived.



#### **4.25. Useful Links**

Department of Electrical Engineering:

<http://engineering.und.edu/electrical/>

School of Graduate Students:

<http://graduateschool.und.edu>

Graduate Students Handbook:

<http://graduateschool.und.edu/graduate-students/current/handbooks-and-guides.cfm>

School of Graduate Studies Forms

<http://graduateschool.und.edu/graduate-students/current/forms.cfm>