

# Engineering

<http://www.und.edu/dept/sem/>

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The College of Engineering and Mines offers the Master of Engineering and the Master of Science degree with majors in chemical engineering, civil engineering, electrical engineering, environmental engineering, and mechanical engineering. The Master of Science degree is offered with majors in chemical engineering, electrical engineering, environmental engineering, geology, and mechanical engineering. The Doctor of Philosophy degree is offered with majors in engineering and geology, and the Doctor of Philosophy in chemical, civil, electrical, geological, and mechanical engineering, and the multi-disciplinary focal areas of energy and environmental engineering is also offered.

## Degree Granted: Doctor of Philosophy (Ph.D.)

The Doctor of Philosophy in 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. Students receive a Ph.D. of Engineering with a specified track of: Civil Engineering, Electrical Engineering, Energy Engineering, Environmental Engineering, Geological Engineering, or Mechanical Engineering. Department of Chemical Engineering offers a discipline specific PhD program in Chemical Engineering.

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. The seminar also serves the important role of providing exposure of all students to a diverse range of multidisciplinary work.

Details pertaining to admission requirements, degree requirements and courses offered can be found in the Degrees section.

## Doctor of Philosophy (Ph.D.)

### Mission Statement and Program Goals

The program recognizes that effective researchers should have extensive expertise in a specialization (track) coupled with a familiarity and awareness of related research needs and the context for applying that expertise. Students enrolled in the Engineering Ph.D. program will develop a broad and inclusive background in the chosen track while also working with faculty from related disciplines to create the interdisciplinary and integrative research paradigms necessary for comprehensive research. A principal goal of the program is to produce Ph.D. research engineers 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 their chosen engineering emphasis area 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 engineering or a related field.

## Doctor of Philosophy (Ph.D.)

### 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 GRE test scores (students with a B.S. engineering degree from an ABET accredited program are not required to submit GRE scores), 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.

Students admitted to an engineering M.S. 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. 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 for the specific track the student wishes to enter. Passing this exam will advance the student to Approved Status in the Doctoral Program in Engineering.

### Financial Assistance

Financial aid in the form of teaching assistantships, research assistantships, fellowship, and internships are available on a competitive basis. Students seeking financial aid should complete their applications by February 15 for Fall admission and September 15 for Spring admission to be given full consideration for financial aid. Assistantships are renewable if progress toward the degree and instructional/research service are satisfactory.

### 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 major 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 Director of the Engineering Program can petition the Dean of the Graduate School for variances in this policy.

## 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 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 track-specific seminar class or ENGR 562-Seminar in Engineering 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 the following:
  - a. A minimum of 27 credit hours of track specific coursework selected from the approved list of courses. Equivalent graduate level coursework may be transferred from a master's program.
  - b. Multidisciplinary emphasis: A minimum of 12 credit hours of 300, 400, or 500 level coursework taken for graduate credit from any department within the University, subject to the approval of the student's adviser. The student is encouraged to structure these courses as a minor. Equivalent course work 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. This examination 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.
9. An oral comprehensive examination is completed when at least 30 credits of post baccalaureate coursework has been completed. This examination will be based significantly on the core of the individual's program of study including work in the minor field of study, but may also include questions related to other track-specific Engineering fundamentals. The examination will be administered by three faculty members from the program of the student's track. Three results of the examination 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. The reexamination must take place no later than 13 months after the initial examination attempt.

10. Students must present to their advisory committee an annual oral progress report describing research progress. One of these presentations will include a detailed presentation of the dissertation research plan. This presentation must be completed at least one year prior to the expected completion of the Ph.D. requirements. These presentations may be made as a partial fulfillment of the students track-specific Seminar or Seminar in Engineering (ENGR 562) requirements with approval of the student's advisory committee.
11. A candidate for the degree must complete an original basic research investigation. Each candidate will complete the research investigation to the satisfaction of the research adviser and the advisory committee and will prepare a dissertation covering the research. The project must represent an original and independent investigation by the student. It is normally expected that the results of the research will be submitted for publication in refereed research journals. The candidate will present and successfully defend the dissertation at the final examination (see School of Graduate Studies requirements (<http://und-public.courseleaf.com/graduatestudies>)).

For Ph.D. students in the Electrical Engineering track, instead of the above requirements in 8-11, the following requirements in 12-16 must be met.

12. 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.

13. 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.

14. 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.

15. The candidate must present and successfully defend the dissertation at the final examination (see School of Graduate Studies requirements (<http://und-public.courseleaf.com/graduatestudies>)). 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.

16. 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.

### ENGR 556. System Dynamics I. 3 Credits.

This course provides an introduction to the System Dynamics field of study which is a computer-aided approach to improving system performance through policy analysis and design. The knowledge and critical thinking skills gained from this course will enable students to work either independently or on interdisciplinary teams to effectively deal with problems arising from dynamically complex systems. Topics include: perspective and process; tools for systems thinking; the dynamics of growth; tools for modeling dynamic systems; instability and oscillation; model testing; and challenges for the future. F.

### ENGR 558. System Dynamics II. 3 Credits.

This course builds on ENGR 556 System Dynamics I. This course will enable students to effectively plan and manage System Dynamics projects by providing knowledge and skill relating to advanced modeling techniques, software capabilities, and client engagement processes. Topics include: model building, documentation and presentation best practices; use of historical data; model calibration and testing techniques; advanced software features; group model building; and implementation challenges. Prerequisite: ENGR 556. S.

### ENGR 562. Seminar in Engineering. 1 Credit.

Conference and reports on current developments in Engineering. Prerequisite: Admission to the Engineering Ph. Repeatable to 3 credits. S/U grading.

### 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. Repeatable.

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

Repeatable to 60 credits. Repeatable.

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

Repeatable. S/U grading.

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

Repeatable to 9 credits. Repeatable to 9 credits.

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

Repeatable to 18 credits. Repeatable to 18 credits.

## Courses

### ENGR 501. Energy, Resources and Policy. 3 Credits.

Structured discussions of energy, resources and policy issues, related to energy security and national and global well-being, based on selected readings. Prerequisite: Consent of instructor.

### ENGR 502. Alternative Energy Systems. 3 Credits.

Provides an interdisciplinary background in alternative energy systems. Any form of energy production different from traditional fossil fuel combustion falls in this category. Such alternate systems include energy production from biomass, gasification of wood and coal, geothermal energy, solar energy (wind energy, fuel cells, and photovoltaics), etc. Prerequisite: Consent of instructor.