

Doctoral Degree Program in the College of Engineering *Revised 8/3/07*

A single Ph.D. degree in Engineering is administered and offered at the College of Engineering level with seven options.

- Ph.D. in Engineering - Civil Engineering Option
- Ph.D. in Engineering - Applied Mechanics Option
- Ph.D. in Engineering - Environmental Engineering Option
- Ph.D. in Engineering - Chemical Engineering Option
- Ph.D. in Engineering - Electrical and Computer Engineering Option
- Ph.D. in Engineering - Industrial Engineering Option
- Ph.D. in Engineering - Mechanical Engineering Option

The College maintains an oversight committee that administers issues of admission and academic standards within the program.

Admission:

1. Contact College or Department for application materials and submit for review.

Minimum College Requirements for Full Admission:

- at least a 3.0 undergraduate GPA
 - Verbal + Quantitative + Analytical GRE scores >1700
 - Favorable letters of recommendation from three references
 - Graduate GPA (if applicable) of 3.2 or better
 - TOEFL scores of 580 (237 for computer test version) or greater for international students or a minimum International English Language Testing System (IELTS) band score of 7.
 - A personal statement of the applicant's objectives
2. Department/s attach summary admission form and circulate application to match students with research needs.
 3. Department Head reviews application in conjunction with faculty recommendation, and exercises one of the following options.
 - a. Full admission - Forward to Option Coordinator.
 - b. Provisional admission - Determine conditions that candidate will be accepted and notes actions to be taken, then forwards to Associate Dean.
 - c. Reject admission because of academic qualifications
 - d. Reject admission based on lack of fit with COE research programs or the lack of a potential advisor

4. Associate Dean for Research and Graduate Studies in the College of Engineering reviews applications, returns to department for submission to the Division of Graduate Education (DGE).
5. DGE reviews application to ensure DGE standards are met with the following possible options.
 - Accept
 - Reject
 - Return to Department Head and Associate Dean with recommendation for further consideration.
6. Applicant is informed of acceptance or rejection letter by DGE.

Acceptance into the program is not always a guarantee of funding (tuition or stipend). Students should establish a dialogue with their chosen department to determine the availability of funding.

If there are course deficiencies that are identified in the student's educational background, these must be completed prior to full admission (matriculation).

In most cases, students will be admitted to the program only if a suitable advisor has already been identified. For those entering without having an advisor/major professor previously identified, students should secure an advisor as early as possible, but no later than the end of the third semester of registration in the Ph.D. program. During the selection process, there should be discussions with the student that include an understanding of funding available to the student and the term of commitment.

Overall Degree Requirements and Program:

To satisfy the requirements for the Ph.D. in Engineering, the student will take a minimum of 60 credits beyond the bachelor's degree according to the table below. Different options within the Ph.D. in Engineering and individual graduate student committees may require additional coursework beyond the minimum requirements (see Declared Option Coursework section later in this document).

For students entering with a Masters degree, up to 24 graded credits may be applied (see below). However, the ENGR 600 and ENGR 610 requirements and a minimum of 13 additional graded course credits must still be taken at Montana State University. Depending on option requirements, students may have the option (with approval of the committee) of using some of their M.S. credits toward the advanced math and numerical methods requirements.

Minimum Degree Requirements for Ph.D. in Engineering

	Description	Minimum Credits
ENGR 610	can only be taken once	3
ENGR 600 [†]	2 credits maximum counted for program	2
Advanced Math*	- see declared option coursework	3
Numerical Methods*	- see declared option coursework	3
Other Graded Courses	- see declared option coursework	24
Dissertation		18
Additional Dissertation or Course credits		7
Total		60

[†]ENGR 600 will be taken once as a two credit class (section 2) by students enrolling as of August, 2007. For students entering the program under these guidelines, ENGR should be taken the semester prior to scheduling the comprehensive exams. All previous students who have already taken one credit of ENGR 600 will enroll for one subsequent credit (section 1). The second credit should be taken the semester prior to the student's comprehensive exam.

*Course content must be above and beyond that typically required for an undergraduate degree in the student's Ph.D. option area.

Credits applied from a prior Masters degree must:

- be graded course credits (e.g., not M.S. thesis or independent study credits),
- have a grade of B or higher (or equivalent), and
- be approved by the student's graduate committee.

Students are expected to attend the COE Seminar Series presentations.

NOTE FOR STUDENTS ENTERING WITHOUT A PRIOR DEGREE IN ENGINEERING

If a student enters the Ph.D. program without a prior degree in engineering from an accredited program, they may have difficulty in pursuing professional registration. If the student's career goals are best served by having a P.E., the student should consult with their department head and major professor to determine what coursework will be required for them to seek licensure. These requirements vary with discipline and the state where licensure is sought. This coursework may be above and beyond what is needed to complete the requirements for the degree.

Examination Requirements

Ph.D. candidates within the College of Engineering at Montana State University must pass a qualifying examination, a comprehensive examination, and a defense of dissertation. The general rules governing these follow. Different options may have more specific requirements; see the specifics under option requirements below.

Ph.D. Qualifying Examination:

The purpose of the qualifying examination is to determine whether the student has sufficiently mastered the core topics within their chosen area of study. It will be a written examination on undergraduate engineering topics determined by the student's Ph.D. option area chosen by the student and administered by that option's committee.

Each Ph.D. Option Committee will offer a qualifying examination annually to students in that option. The qualifying examination will be completed within three semesters but typically within two semesters of matriculation into the Ph.D. program. Failure to take the examination in that time period may result in suspension of Ph.D. candidate status, including stipend. The committee will document the results of the examination in a letter to the student, and in the student's file.

Ph.D. Comprehensive Examination:

The purpose of the Ph.D. comprehensive examination is to determine whether the student is ready for independent research in their chosen area of study. The comprehensive examination is administered by the student's graduate committee (including the Graduate Representative assigned by the Division of Graduate Education), and must be completed within two years after passing the qualifying examination. It is also recommended that the student has taken 2/3 of their graded coursework. In addition, students should have completed ENGR 600 prior to taking the exam; the course is designed to assist the student in preparing their proposal.

The Ph.D. comprehensive examination is comprised of:

- A written proposal for the student's Ph.D. dissertation, and
- An oral presentation of the proposal and oral examination.

The candidate will prepare a written proposal associated with the research topic for the Ph.D. dissertation, in a format designated by the Ph.D. Option. The successful proposal will include a significant literature review, preliminary research to date, and the research proposed to complete the Ph.D. The written proposal will be presented to the student's graduate committee in advance of the oral presentation, by a date agreed to by the student and graduate committee.

The student will then present the dissertation proposal as a public research seminar. This will be followed by a closed-session oral examination by the student's graduate committee on:

- the candidate's current and proposed research;

- the candidate's graduate level understanding of option specific engineering principles; and
- additional topics relevant to the proposed research, including fundamentals of other disciplines drawn upon in the research.

The student's graduate committee will inform the student of the results of the comprehensive examination immediately following the oral examination and committee deliberation, and will document the results on the appropriate form filed with the Division of Graduate Education. A student not passing the comprehensive will have one opportunity to retake the comprehensive after a span of six months has passed. Failure to pass the examination on the second attempt is grounds for dismissal from the Ph.D. program.

There may be additional requirements for these exams specified in the option requirements.

Dissertation Defense:

The dissertation defense will consist of two parts: an open seminar of the research results and a closed session with the student's committee and the graduate representative. Written notification of the results within one week of the defense must be delivered to the Division of Graduate Education and the student. Committee members must approve the dissertation, along with the Department Head, and Vice Provost for Graduate Education. Deadline for the dissertation approval is 14 working days before the end of the term for a given semester.

If failure occurs at the first attempt, a second defense must be held. At least six months must elapse before the second examination takes place, with the time period not to exceed nine months. Failure of the second exam will result in suspension from the program.

Graduation Application:

An application to graduate is prepared by the student, approved by the major professor, and submitted to the Division of Graduate Education through the student's academic department. Applications are due to the DGE September 20th for a Fall Semester graduation, February 5th for a Spring Semester graduation and June 10th for Summer semester graduation.

Declared Option Requirements:

Civil Engineering:

Students must meet the overall requirements for the Ph.D. in Engineering. The student's committee may require additional credits of study based on the student's background and needs. Specific course selections will be determined by the student and his/her committee to support the student's area of study. Up to 24 graded course credits can be applied from an M.S. Degree in meeting the Ph.D. credit requirements, at the discretion of the student's Ph.D. committee.

Applied Mechanics:

Requirements include:

- EM525 Continuum Mechanics 3 credits
- EM510 Elastic and Inelastic Analysis 3 credits
- ME530 Advanced Fluid Mechanics 3 credits
- EM560 Finite Elements Analysis in Engineering 3 credits

The remaining credits are to be established by the student and the Major Professor in consultation with the graduate committee.

Qualifying Examination: The qualifying assessment will be a written examination on relevant undergraduate level topics. In the Applied Mechanics Option these areas include: Statics, Dynamics, Mechanics of Materials, Fluid Mechanics, Mathematics, Thermodynamics and an Area of Undergraduate Focus (e.g. Structures, Hydraulics, Geotechnology, Material Science, Heat Transfer) - as specified by the candidate prior to the exam. The exam will be one hour per topic area in an open book, open notes format. Students must satisfactorily address four of the submitted topics. Problems will be graded by the faculty member who presented that topic. Students will be provided an opportunity to examine their results, however, in order to protect the questions from dissemination they will not be permanently returned. A grade for the qualifying examination of Pass (P), Fail (F) or Remediate (R) will be given for each candidate. In cases where remediation in certain topic areas is required, the Ph.D. advisor will develop a problem solving based plan with the Ph.D. candidate to prepare for a retest on the identified topic areas. The retest must occur prior to completion of the following semester and will be overseen by the Ph.D. Advisor.

Comprehensive Examination: In the Applied Mechanics Option there are two distinct oral examinations: one associated with the Dissertation Proposal and a separate one pertaining to the candidate's graduate level understanding of Engineering Mechanics principals.

Chemical Engineering:

The advance math and numerical methods classes are specified:

ChBE 522/ME 510 - Advanced Math	3 credits
ChBE 525/ME 511 - Advanced Numerical Methods	3 credits

Requirements include:

- ChBE 503 - Thermodynamics 3 credits
- ChBE 530/ME 533 - Transport 3 credits
- ChBE 510 Reactions 3 credits

These requirements leave the remaining credits to be established by the student and the major professor in consultation with the graduate committee.

Qualifying Examination: The qualifier will be a written examination on undergraduate Chemical Engineering including: mass and energy balances, thermodynamics, separations (mass transfer), heat (energy) transfer, fluids, transport phenomena and chemical reaction engineering. The exam will be 1 hour per topic area question in an open book, open notes format and students will choose 4 subjects which they will solve the problems for, from the 7 problems provided. Each question will be graded by the Faculty member that submitted the question. Students will not be given the test back in order to protect the questions from dissemination. The results will be analyzed by a Committee composed of all Faculty and a grade of Pass (P), Fail (F) or Remediate (R) given each candidate. In cases where remediation in certain topic areas is required, the Ph.D. advisor will develop a problem solving based plan with the PhD candidate to prepare for a retest on the identified topic areas. The retest must occur prior to the next fall semester and will be overseen by the PhD. Advisor. The qualifying exam must be completed within two semesters of matriculation into the Ph.D. program. Failure to take the exam in that time period may result in suspension of Ph.D. candidate status, including stipend. The exam will be administered on the second Tuesday in February of the Spring semester to all students required to take the exam in a year.

Comprehensive Examination: The comprehensive exam is required of all Ph.D. candidates, and will be composed of a written NSF-style proposal associated with the research topic for the Ph.D. The proposal should include significant preliminary data on the research to date and the research proposed to complete the Ph.D. The exam will be administered by the student's Ph.D. Advisor and graduate committee. The proposal will be in the NSF format, in compliance with the current year's grant proposal guidelines (gpg) at www.nsf.gov. A written exam on graduate level thermodynamics, transport phenomena, mathematical methods, and kinetics and reactor engineering will be required of graduate students who have a GPA in graduate coursework of less than 3.5. A public oral seminar of 40 minutes plus 10 minutes of public questions, on the research to date and proposed research to complete the Ph.D., will be given by the Ph.D. candidate. This will be followed by a closed-session oral examination of 45-90 minutes by the student's Ph.D. committee on the research and graduate level understanding of Chemical and Biological Engineering principles and any topics relevant to the research including fundamentals of other disciplines drawn on in the research.

Electrical and Computer Engineering:

Students are required to complete 65 credits. Within the course credits, students must take courses in at least 3 of the following 6 areas: Digital Systems, Signals and Controls, Electromagnetic Fields and Optics, Communications, Power and Power Electronics, and MEMS and Electronics.

Mechanical Engineering:

Students are required to take:

Advanced Math

ME510, Advanced Engineering Analysis I 3 credits

Numerical Methods

ME511, Advanced Engineering Analysis II 3 credits

Additional Coursework

EM525 Continuum Mechanics	3 credits
Thermo-fluids Mechanics	3 credits (min)
Solid Mechanics	3 credits (min)

Note: These requirements are satisfied by the MSU MS in Mechanical Engineering

Qualifying Examination: The exam will be administered on the second Tuesday in February of the Spring semester.

The undergraduate Mechanical Engineering topics will include:

- thermodynamics
- heat (energy) transfer
- Fluid Mechanics
- Structural Mechanics
- Materials
- Dynamics and Vibrations
- Mathematics

Students will solve problems in 4 of the 7 topic areas. The exam will be 8 hours duration in an open book, open notes format. Each problem set will be graded by the faculty member that submitted the set. The results will be analyzed by the Mechanical Engineering graduate studies committee, and each candidate will receive a grade of Pass (P), Fail (F) or Remediate (R). Students will not be given the test back in order to protect the questions from dissemination. In cases where remediation in certain topic areas is required, the Ph.D. advisor will develop a problem-solving-based plan with the Ph.D. candidate to prepare for a retest on the identified topic areas. The retest must occur prior to the next fall semester and will be overseen by the Ph.D. Advisor.

Comprehensive Examination: The public research seminar will include 40 minutes for the student's presentation and 10 minutes for questions from the audience. This will be followed immediately by a closed-session oral examination and additional remediation may be required at this point.

Industrial Engineering:

Ph.D. candidates under the IE Option must take a minimum of 30 credits of 500-level courses (in addition to ENGR 610 and ENGR 600), of which at least 18 credits must be I&ME courses. Furthermore, Ph.D. candidates must complete the following coursework with a grade of B or better:

- I&ME 554, I&ME 567, or other course approved by the I&ME Graduate Studies Committee to satisfy the Advanced Math requirement.
- I&ME 509, I&ME 558, or other course approved by the I&ME Graduate Studies Committee to satisfy the Numerical Methods requirement.
- Two courses in the management/quality area: I&ME 434, I&ME 477, I&ME 525, I&ME 548, I&ME 574, I&ME 577.
- Two courses in the integrated systems design area: I&ME 413, I&ME 458, I&ME 471, I&ME 501, I&ME 513, I&ME 534, I&ME 571.

Candidates can meet the above requirements with courses from a prior Master's degree, though not using independent study, project, thesis, or dissertation credits. The student's graduate committee will determine course equivalency as needed, and document such in the student's file.

Qualifying Examination: The qualifying exam will cover three of the following core undergraduate IE topical areas:

- work design and measurement (I&ME 313)
- economic analysis (I&ME 325)
- probability and statistics (I&ME 354)
- linear modeling (I&ME 364)

and three other I&ME courses from among those the student has taken at MSU. The student will request a qualifying exam from the I&ME Graduate Studies Committee within three weeks of the start of the term in which s/he intends to take the qualifying exam. The I&ME Graduate Studies Committee will assemble an examining committee to administer the exam, chaired by the student's advisor.

Environmental Engineering:

Of the credits in the Option Coursework noted above, 12 credits from the following subset of courses are required, with no more than 6 credits at the 400 level. Equivalent courses from prior MS degrees may be used to satisfy this requirement.

Course	Name	Credits
BREN 441	Natural Treatment Systems	3
ENVE443	Air Pollution Control	3
ENVE444	Hazardous Waste Management	3
ENVE445	Hazardous Waste Treatment	3
CE529	Groundwater Contamination	3
ENVE534	Environmental Engineering Investigations	3
ENVE560	Environmental Engineering Processes	2
ENVE561	Environmental Engineering Reactor Theory	2
ENVE562	Water Treatment Processes and Design	3
ENVE563	Waste Water Treatment Processes and Design	3
ENVE564	Environmental Engineering Applications Lab	3
ENVE565	Chemical Sensors & Instrumentation for Env. Biotech.	2
ENVE566	Fundamentals of Biofilm Engineering	3

The remaining credits are to be established by the student and the major professor in consultation with the graduate committee.

Getting Questions Answered

These sources are available to obtain clarification regarding this program and graduate education in general at Montana State University:

Academic Option Departments and/or home department of major advisor (CE, CHE, CS, I&ME, and ECE) (www.coe.montana.edu)

Associate Dean for Research and Graduate Studies, College of Engineering (www.coe.montana.edu)

Division of Graduate Education (www.montana.edu/wwwdg/)

International Programs (www.montana.edu/wwwoie/)