Industrial Engineering, PhD

The PhD in industrial engineering program is intended for students who wish to prepare themselves for a career creating and cultivating new knowledge. In addition to a broad selection of technical research courses, the program emphasizes original research under the close supervision of a faculty member. Students develop an individualized research project that typically includes the design and analysis of experimental or theoretical work or the invention of new processes, techniques, or devices, which ultimately leads to original publications in the academic literature. The training is appropriate for people seeking a career in academia or in research and development in industry.

The coursework requires some diversity of technical skills in three major areas: systems, human factors, and analytics. The systems area emphasizes the design, construction, and analysis of complex systems with interdependent parts that include people and machines. The human factors area emphasizes the interaction of people with systems and includes the study and analysis of people's cognitive and physical limitations. The analytics area emphasizes the application of mathematical formulas, including statistical approaches, as well as algorithmic and computational approaches to deriving knowledge from data. Each area is supported by several faculty members, and many faculty members support multiple areas; see Facilities in the Department of Industrial and Systems Engineering section of the catalog to learn more about each research lab and its activities.

Learning Outcomes

Students will:

- demonstrate a broad knowledge of the field of industrial and systems engineering and deep knowledge in their specific area of study;
- identify and solve problems of value to industry and society;
- demonstrate independent thinking and forge new paths to discovery;
- make meaningful and novel contributions to knowledge in a single or multiple domains;
- disseminate research results to the research and application community;
- demonstrate the ability to lead interdisciplinary teams in pursuit of research; and
- demonstrate ethical and professional behavior.

Requirements

The Doctor of Philosophy program in industrial engineering requires a minimum of 72 s.h. of graduate credit. Students must maintain a UI cumulative grade-point average of at least 3.50 to earn the degree. At least 36 s.h. must be taken in Department of Industrial and Systems Engineering courses (prefix ISE), including at least 24 s.h. in graduate-level courses numbered ISE:5000 and above.

Students must enroll in ENGR:7270 Engineering Ethics, typically in the first or second fall semester of enrollment. ISE:5000 Graduate Seminar: Industrial Engineering must be taken in the first two consecutive semesters of enrollment and one semester (fall or spring) in subsequent academic years. More information about Graduate Seminar requirements can be found in the Graduate Student Handbook on the Department of Industrial and Systems Engineering Graduate Program website. Credit in ISE:5000 and ENGR:7270 may be applied toward the 72 s.h. of required coursework.

Students must successfully complete coursework in each of three focus areas: see the section titled "Breadth Requirement." The academic advisor and/or examining committee may decide that a student must complete other requirements such as additional coursework or the acquisition of specific skills. The actual amount of coursework required is determined with the advice and consent of the academic advisor. Students who earned an MS at the University of Iowa may have satisfied this requirement.

Students are typically expected to have completed three academic years of residence at the University of Iowa, or two years if they already hold a recognized Master of Science. For students who earned an MS at the University of Iowa, no more than 36 s.h. from the MS may be counted toward the PhD. For students who earned an MS from another institution, a maximum of 30 s.h. may be transferred toward the doctoral program. The director of graduate studies reviews the transcripts of new students to determine which requirements have been met from previous coursework.

Excellence in research is the principal requirement for the degree. It is expected that the PhD dissertation research project represents an original and significant contribution to the body of knowledge in the field. At least one accepted research article in a peer-reviewed journal as first author with the research advisor as a co-author, in addition to the presentation of the research in a departmental seminar, are requirements. Submission of three first-authored papers and at least one research presentation at a national conference is typical. In addition, students must fulfill the qualifying requirement, pass the comprehensive examination, submit the Final Examination: Advanced Degree form, complete a Report of Thesis Approval, and submit a copy of their thesis to the Graduate College by following the published guidelines and deadlines.

Breadth Requirement

Students must successfully complete at least 6 s.h. in approved courses numbered 5000 or above offered by the Department of Industrial and Systems Engineering in each of the three focus areas—analytics, human factors, and systems. Students with a relevant academic background in these areas may be excused from the breadth requirement with the approval of the director of graduate studies. Approved courses are listed as follows.

Analytics

Course #	Title	Hours
Two of these:		
ISE:5730	Digital Industry	3
ISE:5740	Design and Analysis of Computer Experiments	3
ISE:6300	Innovation Science and Studies	3
ISE:6380	Deep Learning	3
ISE:6650	Human Analytics and Behavioral Operations	3

ISE:6760	Pattern Recognition for Financial Data	3
ISE:6780	Financial Engineering and Optimization	3
ISE:6790	Advanced Data Analytics and Informatics	3

Human Factors

Course #	Title	Hours
Two of these:		
ISE:5420	Automated Vehicle Systems	3
ISE:5460	User Experience Design	3
ISE:6211	Human Factors in Healthcare Systems	3
ISE:6220	Cognitive Engineering	3
ISE:6410	Research Methods in Human Factors Engineering	3
ISE:6420	Human/Computer Interaction	3
ISE:6450	Human Factors in Aviation	3
ISE:6460	The Design of Virtual Environments	3
ISE:6480	Unmanned Aircraft Systems	3

Systems

Course #	Title	Hours
Two of these:		
ISE:5310	Advanced Computational Design and Manufacturing	3
ISE:5520	Renewable Energy	3
ISE:5620	Design of Experiments	3
ISE:5650	Mechatronics Engineering for Smart Device Design	3
ISE:6350	Computational Intelligence	3
ISE:6810	Advanced Topics on Additive Manufacturing	3

Qualifying Exam

Students interested in pursuing a PhD are initially admitted as MS nonthesis students until they have completed the qualifying examination. This is typically achieved within their first three semesters if beginning the program without an MS, or within the first two semesters if beginning the program with an MS. Once the exam is passed, students are formally admitted to the PhD program. The purpose of this qualifier is to determine a student's proficiency in research and scholarship.

Comprehensive Examination

The general rules for the administration of the PhD comprehensive examination are contained in the policies and procedures of the Graduate College. The tradition in the department is for the comprehensive examination to consist of a written and oral component. Students write and submit a comprehensive examination document, usually called the dissertation research proposal, to each member of the examination committee two weeks before the examination date. During the examination, students make a roughly 30-minute presentation on the content of the research proposal. Committee members may ask questions regarding the proposal before, during, or after the oral presentation. Having satisfactorily completed the comprehensive examination, students are accepted as candidates for the PhD.

Final Examination (Dissertation Defense)

Each student must defend the completed dissertation in the final examination, which is conducted by the examining committee.

En Passant Option

Students admitted to the PhD program may elect to earn their MS through the *en passant* option, with the permission of their PhD committee. This option allows students to write an English-language manuscript as the first author and submit it to a peer-reviewed research journal in lieu of writing the MS thesis. With this option, students, in conjunction with their academic advisor, author a paper that serves as the foundation for the PhD research. The decision to select this option must be made before the qualifying examination. The committee may determine, based on the published or submitted scholarship to peer-reviewed journals, that the presentation of a separate research thesis is not necessary. In this case, up to 9 s.h. in ISE:5999 Research: Industrial Engineering MS Thesis may be counted toward the nonthesis option. Students choosing the *en passant* option generally receive an MS without the thesis designation.

For more detailed information about program requirements, see Graduate Student Handbook on the Department of Industrial and Systems Engineering Graduate Program website.

Admission

Applicants must meet the admission requirements of the Graduate College; for detailed information about Graduate College policies, see the Manual of Rules and Regulations on the Graduate College website.

Admission to the graduate program is competitive and based on an applicant's previous coursework, research, and industrial experience. The general admission standards are intended to maintain the quality of the graduate program and to ensure the sufficient preparation required for timely degree completion. Specific admission standards may be waived by the Graduate Admissions Committee when other evidence of competence is compelling. These standards are minimum standards, and meeting these standards does not ensure admission to the program; admitted students typically exceed these standards.

Applicants are expected to have a minimum cumulative grade-point average of at least 3.00 on a 4.00 scale and have earned a BSE in industrial engineering degree or in a related science or engineering discipline. Applicants are not required to submit the results of the Graduate Record Examination (GRE) General Test.

Applicants must arrange to have three letters of recommendation sent to the department online through the University of Iowa Admissions website. The letters should be completed by persons who are well acquainted with the applicant and the ability of the applicant to undertake graduate work in industrial or systems engineering.

While the department considers applications at any time, first consideration is given to students who have their application materials, including their application, transcripts, English language test scores (DET, IELTS, or TOEFL), and the required

letters of recommendation, completed by the admission priority deadline as found on the Graduate Admissions website. The director of graduate admissions is responsible for overseeing the graduate recruiting activities and the admissions procedures in the department. The director serves as the point of initial contact between prospective graduate students and the department and maintains a record of each qualified applicant in the departmental office. The director, in consultation with the Graduate Admissions Committee and the department chair, screens applicants and ultimately determines which applicants are extended offers of admission.

Applicants With Degrees Not in Industrial or Systems Engineering

The department encourages students with degrees in other scientific disciplines, such as computer science, mathematics, physics, or other engineering disciplines, to apply for admission. Some students may have already completed MS degrees; however, these students are expected to attain proficiency in specified core areas of industrial and systems engineering equivalent to entering graduate students who hold a BSE degree in industrial engineering. The background of each student admitted to the program with a degree other than in industrial or systems engineering is reviewed by the faculty members. These proficiencies are intended to ensure that each admitted graduate student is able to fully participate in all industrial and systems engineering discipline areas at some level, even while advanced courses in certain areas may not be immediately accessible to all graduate students.

Career Advancement

Industrial and systems engineers have many opportunities for employment and service in industrial, government, research, and public service organizations. Employment opportunities are among the most varied in the engineering field. Industrial and systems engineers are employed by manufacturing and energy firms, government agencies, and service organizations such as airlines, banks, hospitals, health care groups, and consulting companies.

The PhD is a gateway toward careers of learning and creation. Employers typically hire people with doctorates to run laboratories, create research directions, and supervise other engineers at the boundaries of knowledge. PhD-level researchers generally enjoy great freedom and tailored work environments as they explore and learn to help create new visions of tomorrow. A PhD opens up academic, research, and entrepreneurial possibilities limited only by one's drive and creativity. Positions are often found through announcements in trade journals, international conferences, and specialized job-posting services. Students often work with faculty to identify and apply for appropriate positions. It is rare that students do not find an appropriate position before completing their thesis.

Academic Plans

Sample Plan of Study

Sample plans represent one way to complete a program of study. Actual course selection and sequence will vary and should be discussed with an academic advisor. For additional sample plans, see MyUI.

Industrial Engineering, PhD

Course	Title	Hours
Academic Career		
Any Semester		
72 s.h. must be graduate level coursework; graduate transfer credits allowed upon approval. More information is included in the General Catalog and on department website. [a]		
Graduate College program GPA of at least 3.50 is required. [b]		
	Hours	**0**
First Year		
Fall		
ENGR:7270	Engineering Ethics [c]	1
ISE:5000	Graduate Seminar: Industrial Engineering [d]	1
ISE:7999	Research: Industrial Engineering PhD Dissertation	3
Analytics focus area course [e]		3
Human factors focus area course [e]		3
	Hours	**11**
Spring		
Exam: Doctoral Qualifying Exam [f]		
ISE:5000	Graduate Seminar: Industrial Engineering [d]	1
ISE:7999	Research: Industrial Engineering PhD Dissertation	3
Analytics focus area course [e]		3
Systems focus area course [e]		3
	Hours	**10**
Second Year		
Fall		
ISE:5000	Graduate Seminar: Industrial Engineering [d]	1
ISE:7999	Research: Industrial Engineering PhD Dissertation	3
Human factors focus area course [e]		3
Systems focus area course [e]		3
	Hours	**10**
Spring		
ISE:7999	Research: Industrial Engineering PhD Dissertation	3
Elective course [g]		3
Elective course [g]		3
	Hours	**9**
Third Year		
Any Semester		
Exam: Doctoral Comprehensive Exam [h]		
	Hours	**0**
Fall		
ISE:5000	Graduate Seminar: Industrial Engineering [d]	1
ISE:7999	Research: Industrial Engineering PhD Dissertation	8
	Hours	**9**

Spring		
ISE:7999	Research: Industrial Engineering PhD Dissertation	9
	Hours	**9**
Fourth Year		
Fall		
ISE:5000	Graduate Seminar: Industrial Engineering [d]	1
ISE:7999	Research: Industrial Engineering PhD Dissertation	8
	Hours	**9**
Spring		
ISE:7999	Research: Industrial Engineering PhD Dissertation	5
Exam: Doctoral Final Exam [i]		
	Hours	**5**
	Total Hours	**72**

a Students must complete specific requirements in the University of Iowa Graduate College after program admission. Refer to the Graduate College website and the Manual of Rules and Regulations for more information.

b Graduate College program GPA is comprised of all courses that are approved degree requirements. If a student takes more than the minimum required number of semester hours to complete the degree, but all courses taken are eligible to count toward the degree, those courses will be included in the Graduate College program GPA.

c Students must enroll in ENGR:7270, typically in the first or second semester of enrollment; may count towards total semester hours for the degree.

d ISE:5000 must be taken in the first two consecutive semesters of enrollment, and one semester (fall or spring) in subsequent academic years; may count towards total semester hours for the degree.

e Students must complete at least 6 s.h. in approved ISE courses numbered 5000 or above in each of the three focus areas: analytics, human factors, and systems. See the General Catalog for list of approved courses.

f Typically taken during the second semester of enrollment; more information is found in the General Catalog and on department website.

g Work with faculty advisor to determine appropriate graduate elective coursework and sequence.

h Written and oral exam to be completed after passing the qualifying exam and upon completion of required coursework; typically done by the end of third year.

i Dissertation defense.