

# INDUSTRIAL ENGINEERING, PHD

## REQUIREMENTS

### MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum degree requirements (<https://guide.wisc.edu/graduate/#requirements>) and policies (<https://guide.wisc.edu/graduate/#policies>), in addition to the program requirements listed below.

### MAJOR REQUIREMENTS

#### MODE OF INSTRUCTION

Face to Face	Evening/ Weekend	Online	Hybrid	Accelerated
Yes	No	No	No	No

#### Mode of Instruction Definitions

**Accelerated:** Accelerated programs are offered at a fast pace that condenses the time to completion. Students typically take enough credits aimed at completing the program in a year or two.

**Evening/Weekend:** Courses meet on the UW–Madison campus only in evenings and/or on weekends to accommodate typical business schedules. Students have the advantages of face-to-face courses with the flexibility to keep work and other life commitments.

**Face-to-Face:** Courses typically meet during weekdays on the UW–Madison Campus.

**Hybrid:** These programs combine face-to-face and online learning formats. Contact the program for more specific information.

**Online:** These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.

### CURRICULAR REQUIREMENTS

Requirement Detail	
Minimum Credit Requirement	51 credits
Minimum Residence Credit Requirement	32 credits
Minimum Graduate Coursework Requirement	26 credits must be graduate-level coursework. Refer to the Graduate School: Minimum Graduate Coursework (50%) Requirement policy: <a href="https://policy.wisc.edu/library/UW-1244">https://policy.wisc.edu/library/UW-1244</a> ( <a href="https://policy.wisc.edu/library/UW-1244/">https://policy.wisc.edu/library/UW-1244/</a> ).
Overall Graduate GPA Requirement	3.00 GPA required. Refer to the Graduate School: Grade Point Average (GPA) Requirement policy: <a href="https://policy.wisc.edu/library/UW-1203">https://policy.wisc.edu/library/UW-1203</a> ( <a href="https://policy.wisc.edu/library/UW-1203/">https://policy.wisc.edu/library/UW-1203/</a> ).

**Other Grade Requirements** Grades of D received by a candidate in any graduate course will not be counted as satisfying degree requirements. These grades will, however, be counted in the graduate GPA.

Students must earn a grade of B or above in all courses applied toward the program breadth requirement.

Students must earn a grade of C or better, or a grade of S (satisfactory) if taken on a pass/fail basis, in the colloquium/lecture series (I&#160;SY&#160;E&#160;961).

Students in the Human Factors and Ergonomics pathway must receive a grade of AB or better in at least 3 credits in each of the following areas: cognitive ergonomics, sociotechnical systems/macro ergonomics, and physical ergonomics to take the qualifying exam. Refer to pathway for more information.

**Assessments and Examinations** Qualifying exams, preliminary exams, and a final dissertation defense are required of all students. Details may be found in the program handbook.

**Language Requirements** No language requirements.

**Graduate School Breadth Requirement** All doctoral students are required to complete a doctoral minor or graduate/professional certificate. Refer to the Graduate School: Breadth Requirement in Doctoral Training policy: <https://policy.wisc.edu/library/UW-1200> (<https://policy.wisc.edu/library/UW-1200/>).

The program also has additional breadth requirements. See details below.

### REQUIRED COURSES

Students choose one of the following Industrial and Systems Engineering (I SY E) research areas (<https://engineering.wisc.edu/departments/industrial-systems-engineering/research/>) for their PhD program, course and research planning in consultation with their faculty advisor.

All program PhD students must complete the following additional requirements.

#### Program Breadth

The breadth requirement is to make sure the PhD student achieves minimum competence in multiple areas of industrial and systems engineering. Students must take at least two courses (6 credits) in Methodology and two courses (6 credits) in Application areas selected by the student and approved by their advisor. Courses used to satisfy the breadth requirement must be completed by end of the semester the student is completing their preliminary examination. Prior coursework may be applied toward the breadth requirement (including courses taken as an undergraduate), but requires program approval and includes a review of the course title and syllabus.

#### Graduate School Breadth

Students must complete the Graduate School's breadth requirement by completing a cohesive group of courses outside of the major. These courses should help students in their research preparation. Students must consult their advisor before deciding how to fulfill this requirement.

## Colloquium/Lecture Series

Students must enroll in I SY E 961 Graduate Seminar in Industrial Engineering for at least three semesters. The Industrial and Systems Engineering (ISyE) Colloquia and the Systems, Information, Learning and Optimization (SILO) seminars also satisfy this requirement.

## Teaching Assistant

Recognizing the importance of instructional training to our PhD students, each student in the PhD program is required to serve as a teaching assistant for at least one semester during their program. Requests for a partial or full waiver of this requirement should be submitted in writing to the Associate Chair for Graduate Studies and will be reviewed by the Academic Affairs Cluster.

Code	Title	Credits
<b>Research Area Pathway <sup>1</sup></b>		
	Students complete a research area pathway ( <a href="https://engineering.wisc.edu/departments/industrial-systems-engineering/research">https://engineering.wisc.edu/departments/industrial-systems-engineering/research</a> ( <a href="https://engineering.wisc.edu/departments/industrial-systems-engineering/research/">https://engineering.wisc.edu/departments/industrial-systems-engineering/research/</a> )) and plan of study chosen in consultation with advisor.	27
<b>Program Breadth Requirement</b>		
	Students must complete 12 credits of coursework in multiple areas of industrial and systems engineering, including 6 credits in methodology and 6 credits in application courses.	12
<i>Methodology</i>		
I SY E 313	Engineering Economic Analysis	
I SY E 320	Simulation and Probabilistic Modeling	
I SY E 323	Operations Research–Deterministic Modeling	
I SY E/ PSYCH 349	Introduction to Human Factors	
I SY E 412	Fundamentals of Industrial Data Analytics	
I SY E/COMP SCI/ MATH 425	Introduction to Combinatorial Optimization	
I SY E/M E 512	Inspection, Quality Control and Reliability	
I SY E 515	Engineering Management of Continuous Process Improvement	
I SY E 516	Introduction to Decision Analysis	
I SY E/COMP SCI/ DS 518	Wearable Technology	
I SY E 521	Machine Learning in Action for Industrial Engineers	
I SY E/COMP SCI/ E C E 524	Introduction to Optimization	
I SY E/COMP SCI/ MATH/STAT 525	Linear Optimization	
I SY E/ COMP SCI 526	Advanced Linear Programming	
I SY E/ PSYCH 549	Human Factors Engineering	
I SY E 552	Human Factors Engineering Design and Evaluation	

I SY E 555	Human Performance and Accident Causation
I SY E 562	Human Factors of Data Science and Machine Learning
I SY E/B M E 564	Occupational Ergonomics and Biomechanics
I SY E 575	Introduction to Quality Engineering
I SY E 602	Special Topics in Human Factors
I SY E 603	Special Topics in Engineering Analytics and Operations Research
I SY E 618	Quality Engineering and Quality Management
I SY E 620	Simulation Modeling and Analysis
I SY E 624	Stochastic Modeling Techniques
I SY E/MATH/ OTM/STAT 632	Introduction to Stochastic Processes
I SY E/ PSYCH 653	Organization and Job Design
I SY E/ COMP SCI 719	Stochastic Programming
I SY E/ INFO SYS 722	Computer-Based Data Management
I SY E/ COMP SCI 723	Dynamic Programming and Associated Topics
I SY E/COMP SCI/ MATH/STAT 726	Nonlinear Optimization I
I SY E/ COMP SCI 727	Convex Analysis
I SY E/COMP SCI/ MATH 730	Nonlinear Optimization II
<i>Application</i>	
I SY E 315	Production Planning and Control
I SY E 415	Introduction to Manufacturing Systems, Design and Analysis
I SY E 417	Health Systems Engineering
I SY E/M E 510	Facilities Planning
I SY E 517	Decision Making in Health Care
I SY E 520	Quality Assurance Systems
I SY E 557	Human Factors Engineering for Healthcare Systems
I SY E 604	Special Topics in Manufacturing and Supply Chain Management
I SY E 605	Computer Integrated Manufacturing
I SY E 606	Special Topics in Healthcare Systems Engineering
I SY E/ PHARMACY 608	Safety and Quality in the Medication Use System
I SY E 612	Information Sensing and Analysis for Manufacturing Processes
I SY E 615	Production Systems Control
I SY E/M E 641	Design and Analysis of Manufacturing Systems
I SY E/M E 643	Performance Analysis of Manufacturing Systems
I SY E/B M E 662	Design and Human Disability and Aging

ISY E/ POP HLTH 703	Quality of Health Care: Evaluation and Assurance
ISY E/M H R 729	Behavioral Analysis of Management Decision Making
ISY E/ POP HLTH 875	Cost Effectiveness Analysis in Health and Healthcare

**Graduate School Breadth**

Chosen in consultation with advisor, students must complete a cohesive group of courses outside of the major. This requirement must be completed by the end of the semester during which the preliminary exam is taken.<sup>1</sup>

**Colloquium/Lecture Series**

Complete at least 3 semesters by the end of the semester the student is completing their preliminary examination.

ISY E 961	Graduate Seminar in Industrial Engineering
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**Total Credits** **51**

**Operations Research, Optimization, and Analytics Pathway<sup>1</sup>**

The following is a list of recommended courses to prepare for the research area's qualifying examination.

Code	Title	Credits
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**Courses Recommended for DS/OR Qualifying Exam:**

ISY E/COMP SCI/ E C E 524	Introduction to Optimization	3
ISY E/COMP SCI/ MATH/STAT 525	Linear Optimization	3
ISY E 620	Simulation Modeling and Analysis	3
ISY E 624	Stochastic Modeling Techniques	3
ISY E/MATH/OTM/ STAT 632	Introduction to Stochastic Processes	3
ISY E/COMP SCI/ MATH 728	Integer Optimization	3

**Courses Recommended for Optimization Qualifying Exam:**

ISY E/COMP SCI/ E C E 524	Introduction to Optimization	3
ISY E/COMP SCI/ MATH/STAT 525	Linear Optimization	3
ISY E/COMP SCI/ MATH/STAT 726	Nonlinear Optimization I	3
ISY E/COMP SCI/ MATH 728	Integer Optimization	3
ISY E/COMP SCI/ MATH 730	Nonlinear Optimization II	3

The following is a list of suggested courses a student may choose to complete in this research area.

ISY E 412	Fundamentals of Industrial Data Analytics	3
ISY E/COMP SCI/ MATH 425	Introduction to Combinatorial Optimization	3
ISY E/M E 512	Inspection, Quality Control and Reliability	3
ISY E 516	Introduction to Decision Analysis	3
ISY E 517	Decision Making in Health Care	3

ISY E 575	Introduction to Quality Engineering	3
ISY E 603	Special Topics in Engineering Analytics and Operations Research	1-3
ISY E 604	Special Topics in Manufacturing and Supply Chain Management	1-3
ISY E 612	Information Sensing and Analysis for Manufacturing Processes	3
ISY E/MATH/OTM/ STAT 632	Introduction to Stochastic Processes	3
ISY E 645	Engineering Models for Supply Chains	3
ISY E 649	Interactive Data Analytics	3
ISY E/ COMP SCI 719	Stochastic Programming	3
ISY E/ COMP SCI 723	Dynamic Programming and Associated Topics	3
ISY E/ COMP SCI 727	Convex Analysis	3
ISY E 961	Graduate Seminar in Industrial Engineering	3

<sup>1</sup> These pathways are internal to the program and represent different curricular paths a student can follow to earn this degree. Pathway names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

**Health Systems Engineering Pathway<sup>1</sup>**

The following is a list of highly recommended courses to complete in this research area.

Code	Title	Credits
ISY E 417	Health Systems Engineering	3
ISY E 517	Decision Making in Health Care	3
ISY E 606	Special Topics in Healthcare Systems Engineering	1-3
ISY E/ POP HLTH 703	Quality of Health Care: Evaluation and Assurance	1-3

The following is a list of suggested courses a student may choose to complete in this research area.

ISY E 412	Fundamentals of Industrial Data Analytics	3
ISY E 415	Introduction to Manufacturing Systems, Design and Analysis	3
ISY E 521	Machine Learning in Action for Industrial Engineers	3
ISY E 555	Human Performance and Accident Causation	3
ISY E 575	Introduction to Quality Engineering	3
ISY E 601	Special Topics in Industrial Engineering <sup>2</sup>	1-3
ISY E/ PHARMACY 608	Safety and Quality in the Medication Use System	3
ISY E 615	Production Systems Control	3
ISY E 620	Simulation Modeling and Analysis	3
ISY E 624	Stochastic Modeling Techniques	3
ISY E/M E 643	Performance Analysis of Manufacturing Systems	3

ISY E/M H R 729	Behavioral Analysis of Management Decision Making	3
ISY E/ POP HLTH 875	Cost Effectiveness Analysis in Health and Healthcare	3
B M I/ COMP SCI 576	Introduction to Bioinformatics	3
B M I 773	Clinical Research Informatics	3
B M I/ COMP SCI 776	Advanced Bioinformatics	3
ISY E 961	Graduate Seminar in Industrial Engineering	3

<sup>1</sup> These pathways are internal to the program and represent different curricular paths a student can follow to earn this degree. Pathway names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

<sup>2</sup> Topics vary for this course. Obtain advance approval from your faculty advisor.

### Advanced Manufacturing and Industrial AI Pathway<sup>1</sup>

The following is a list of courses students may choose to complete in this research area.

Code	Title	Credits
<b>Courses Recommended for Manufacturing Qualifying Exam:</b>		
ISY E/M E 510	Facilities Planning	3
ISY E/M E 512	Inspection, Quality Control and Reliability	3
ISY E 605	Computer Integrated Manufacturing	3
ISY E 624	Stochastic Modeling Techniques	3
or ISY E/M E 643	Performance Analysis of Manufacturing Systems	
ISY E 604	Special Topics in Manufacturing and Supply Chain Management <sup>2</sup>	3
or ISY E 645	Engineering Models for Supply Chains	
The following is a list of suggested courses a student may choose to complete in this research area.		
ISY E 412	Fundamentals of Industrial Data Analytics	3
ISY E 415	Introduction to Manufacturing Systems, Design and Analysis	3
ISY E 515	Engineering Management of Continuous Process Improvement	3
ISY E 575	Introduction to Quality Engineering	3
ISY E 601	Special Topics in Industrial Engineering <sup>2</sup>	1-3
ISY E 603	Special Topics in Engineering Analytics and Operations Research <sup>2</sup>	1-3
ISY E 612	Information Sensing and Analysis for Manufacturing Processes	3
ISY E 615	Production Systems Control	3
ISY E 620	Simulation Modeling and Analysis	3
ISY E/M E 641	Design and Analysis of Manufacturing Systems	3
ISY E 649	Interactive Data Analytics	3
ISY E/ COMP SCI 723	Dynamic Programming and Associated Topics	3

ISY E 823	Special Topics in Operations Research <sup>2</sup>	1-3
ISY E 961	Graduate Seminar in Industrial Engineering	3

<sup>1</sup> These pathways are internal to the program and represent different curricular paths a student can follow to earn this degree. Pathway names do not appear in the Graduate School admissions application, and they will not appear on the transcript.

<sup>2</sup> Topics vary for this course. Obtain advance approval from your faculty advisor.

### Human Factors and Ergonomics Pathway<sup>1</sup>

Students in this research area must complete a depth requirement, which includes coursework and exam components. Students may use prior coursework to satisfy the coursework requirement to be eligible for the qualifying exam. HFE PhD students must complete an additional coursework and exam component.

Code	Title	Credits
The following is a list of suggested courses a student may choose to complete in this research area.		
ISY E/COMP SCI/ DS 518	Wearable Technology	3
ISY E 552	Human Factors Engineering Design and Evaluation	3
ISY E 555	Human Performance and Accident Causation	3
ISY E 562	Human Factors of Data Science and Machine Learning	3
ISY E/B M E 564	Occupational Ergonomics and Biomechanics	3
ISY E 601	Special Topics in Industrial Engineering <sup>2</sup>	1-3
ISY E 602	Special Topics in Human Factors <sup>2</sup>	3
ISY E/B M E 662	Design and Human Disability and Aging	3
ISY E 699	Advanced Independent Study <sup>2</sup>	1-5
ISY E/PSYCH 854	Special Topics in Organization Design <sup>2</sup>	1-3
ISY E/PSYCH 859	Special Topics in Human Factors Engineering <sup>2</sup>	1-3
ISY E 961	Graduate Seminar in Industrial Engineering <sup>2</sup>	3
CIV ENGR 679	Special Topics in Transportation and City Planning <sup>2</sup>	3

Tools and Methods: Various courses in the categories of Research Methods, Statistics, Qualitative Research, Biomechanics Methods, and Psychology count as "Tools and Methods." The Human Factors and Ergonomics faculty group updates the list of "Tools and Methods" courses, and advisors decide which set of courses are appropriate for each student. Work with your faculty advisor regarding non-ISY E course work.

**Human Factors and Ergonomics Course Requirement**

**Code**                      **Title**    **Credits**

To take the qualifying exam, a student will have to have received a grade of AB or better in at least 3 credits in each of the three areas below. Courses taken during undergraduate studies can be used to satisfy this requirement:

**Cognitive Ergonomics**

Students must complete one of the following courses. 3

I SY E 555	Human Performance and Accident Causation	
I SY E 601	Special Topics in Industrial Engineering <sup>2</sup>	
I SY E 602	Special Topics in Human Factors <sup>2</sup>	
I SY E 699	Advanced Independent Study <sup>2</sup>	
I SY E/ PSYCH 859	Special Topics in Human Factors Engineering <sup>2</sup>	

**Sociotechnical Systems / Macroergonomics:**

Students must complete one of the following courses. 3

I SY E 555	Human Performance and Accident Causation	
I SY E/ PSYCH 653	Organization and Job Design <sup>2</sup>	
I SY E 601	Special Topics in Industrial Engineering <sup>2</sup>	
I SY E 602	Special Topics in Human Factors <sup>2</sup>	
I SY E 699	Advanced Independent Study <sup>2</sup>	
I SY E/ PSYCH 854	Special Topics in Organization Design <sup>2</sup>	

**Physical Ergonomics**

Students must complete one of the following courses. 3

I SY E 555	Human Performance and Accident Causation	
I SY E/B M E 564	Occupational Ergonomics and Biomechanics	
I SY E/B M E 662	Design and Human Disability and Aging	
I SY E 601	Special Topics in Industrial Engineering <sup>2</sup>	
I SY E 602	Special Topics in Human Factors <sup>2</sup>	
I SY E 699	Advanced Independent Study <sup>2</sup>	
I SY E/ PSYCH 854	Special Topics in Organization Design <sup>2</sup>	

**Seminar / Special Topics in Human Factors**

Students must complete at least 12 credits of seminar or special topics courses numbered 700 or above, including 6 credits of in the Human Factors and Ergonomics area. Students may apply seminar courses to fulfill the program's breadth requirement if not Human Factors focused courses. 12

Prior to defending their dissertation, Human Factors and Ergonomics PhD students must complete at least six seminar/special topics courses numbered 700 or above totaling a minimum of 12 credits; at least 6 credits of these must be in the Human Factors and Ergonomics area. Seminar credits outside the Human Factors and Ergonomics area may be used to satisfy the Industrial Engineering Breadth requirement. Other courses may qualify. Students may submit courses to the Human Factors and Ergonomics Area group for consideration. Transfer students should submit a course syllabus or description and transcript for any courses from other institutions that they would like to have considered for satisfaction of this requirement. The Human Factors and Ergonomics Area group will make this decision.

I SY E 961	Graduate Seminar in Industrial Engineering	3
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<sup>2</sup> Topics vary for this course. Obtain advance approval from your faculty advisor.