

The requirements for completing a doctor of philosophy (Ph.D.) degree in the Department of Industrial and Systems Engineering (ISE) are provided in the following sections. A summary of the steps is provided below, followed by more detail in the following sections.

1. Pass a set of core courses.
2. Pass a set of elective courses.
3. Pass the Ph.D. qualifying exam.
4. Pass a formal “first-year” review conducted by the faculty. This review will be made each year until it is passed, as long as a student remains in the program.
5. Form a doctoral committee, complete a dissertation proposal, and successfully defend this proposal to the committee.
6. Pass a general exam conducted by the doctoral committee.
7. Pass annual progress reviews conducted by the doctoral committee.
8. Successfully defend a doctoral dissertation.
9. Satisfy any additional Ph.D. degree requirements specified by the P.C. Rossin College of Engineering and Applied Science (refer to Lehigh University Catalog).

## I. Course Requirements

The core course requirements for all students are as follows. Each course must be taken in the time indicated, unless a student has taken the course at Lehigh prior to starting the Ph.D. program or prior approval has been obtained from the ISE Director of Graduate Studies (DGS).

<b>1<sup>st</sup> year Fall Semester</b>	<b>Course Title</b>
ISE 401	Convex Analysis (3)
ISE 406	Introduction to Mathematical Optimization (3)
STAT 410	Random Processes and Applications (3)

<b>1<sup>st</sup> year Spring Semester</b>	<b>Course Title</b>
ISE 402	Applied Models in Operations Research (3)
ISE 417	Nonlinear Optimization (3)
ISE 418	Discrete Optimization (3)

<b>2<sup>nd</sup> year</b>	<b>Course Title</b>
ISE 407	Computational Methods in Optimization (3)
ENGR 495	Technical Writing for Engineers and Scientists (1)

The overall Ph.D. course requirements include 13 courses (37 credits) consisting of

- the core courses listed above and
- five additional 3-credit, Ph.D.-level, non-dissertation (i.e., not ISE 499) courses.

A “Ph.D.-level” course is a 400-level course that has been determined to be intended for Ph.D. students. Students should consult with the ISE DGS about which 400-level courses are Ph.D.-level. (The determination is made by the instructor of the course, who informs the ISE DGS.)

Each elective (i.e., non-core) course can be taken within ISE or in another department. In the latter case when a student wishes to use a Ph.D.-level course outside of ISE to cover a non-core course requirement, the student must obtain approval from their research advisor prior to registering for the course.

A “Readings” course (i.e., ISE 461) cannot be used to cover any of these course requirements without prior approval from the ISE DGS.

For students who enter Lehigh with a Master’s degree, completion of the degree requires an additional 11 credits, totalling 48 credits. Those entering without a Master’s degree need to complete an additional 35 credits, totalling 72 credits. These credits can be obtained via courses or dissertation (ISE 499) credits.

In case a student lacks the background necessary to pass a course, the student may be given permission by the ISE DGS to take a preparatory course, which may be below Ph.D.-level. Students must seek approval to do this prior to registering for and taking the preparatory course. The credits for such a course may be used to fulfill the Ph.D. course requirements with prior approval from the ISE DGS.

**For students who have taken a course at another institution equivalent to a core course:** If a student has passed a course at another institution that the student believes is equivalent to a *core course* for the program, then the student may fulfill the course requirement by successfully passing an examination by the instructor of the core course in question. Note, however, that this does not reduce the required number of *credits* and the student will not receive formal credit for the course. Any such examination(s) should be scheduled in consultation with the ISE DGS.

**For students who have taken a Ph.D.-level course at Lehigh:** If a student has passed any of the core courses or other Ph.D.-level courses at Lehigh prior to starting the ISE Ph.D. program, then these can be used to fulfill *course* requirements if approval is granted by the student’s research advisor and the ISE DGS. Note, however, that this does not reduce the required number of *credits* for the Ph.D. program.

## II. Qualifying Exam

Immediately following final exams at the end of the first year, all Ph.D. students must take the qualifying exam. (The exam may be taken in a later semester only with the approval of the ISE DGS. Approval should be sought at least one month prior to the end of the Spring semester.) The purpose of the exam is to:

1. Test the student’s knowledge and strength in basic topics of Industrial and Systems Engineering.
2. Assess the student’s ability to conduct original research.
3. Assess the student’s ability to communicate, both orally and in writing.
4. Test the student’s ability to apply the material from the core courses taken during the first year.

All students taking the exam at the same time are presented with three (sets of) research questions. Over a two-week period, the students are to study the questions and prepare a written report and an oral presentation with their answers to be presented to a committee of three faculty members. These faculty members assess the student’s performance using an evaluation form that will be made available to the student(s) ahead of time, upon request. The results of the exam are either pass or fail. These results are used as input to the “first-year” review, described in Section III below.

NOTE: A student entering the Ph.D. program without a Master’s degree may petition to delay their first qualifying exam until the end of their third or fourth semester of study. This does not exempt the student from a “first-year” review (see Section III). The timing of the qualifying exam for part-time students will be determined based on a customized program of study developed in consultation with the ISE DGS.

### **III. Annual Reviews**

#### **First Year**

At the end of the first academic year, every Ph.D. student will undergo a review consisting of:

1. Evaluation of grades.
2. Evaluation of qualifier exam results (if applicable).
3. Evaluation of research project carried out during the first year.
4. Other input as deemed relevant by the faculty.

The results of this review are determined by a vote of the faculty and may be either pass, conditional pass, or fail. A pass indicates that the student may continue in the program and should start to form a doctoral committee. A conditional pass indicates that the student may continue, subject to certain stated conditions being fulfilled. These conditions may include, but are not limited to, retaking the qualifying exam, writing a research report, taking additional coursework, or achieving a minimum GPA during subsequent semesters. Failure of the review will result in a student's dismissal from the Ph.D. program, after which the student may petition to transfer to an M.S. degree program in order to receive a degree before leaving the department.

In cases in which a student has arranged to delay the scheduling of the qualifying exam, is required to retake it, or has conditionally passed a prior review, a supplemental review will take place directly following any off-cycle offering of the qualifying exam or completion of a required conditional action. When a student feels that the conditional actions have been completed, he or she should notify the ISE DGS and request a supplemental review. The ISE DGS may also call for the supplemental review to take place as deemed appropriate. For part-time students whose exam date extends beyond the second year, annual reviews will be conducted by the faculty each year until the qualifying exam is passed successfully.

#### **Subsequent Years**

Following successful completion of the qualifying exam and successful fulfillment of any conditions imposed as a result of the subsequent review, each student is required to identify a dissertation advisor, identify a dissertation topic, and form a doctoral committee subject to the approval of the student's research advisor. In subsequent years the doctoral committee is expected to convene about once a year – for the proposal defense, for the general exam and, finally, for the dissertation defense. If any of these are delayed, a meeting with the doctoral committee should be conducted to update the committee on the student's progress and reasons for delay.