

## Program Requirements Lehigh ISE Ph.D. Program

The requirements for completing a Doctor of Philosophy (Ph.D.) degree in the Department of Industrial and Systems Engineering (ISE) within the P.C. Rossin College of Engineering and Applied Science (RCEAS) at Lehigh University are provided in the following sections. A summary of the steps is provided below, followed by more detail in the following sections.

1. Department Requirements:
  - a. Complete a set of core courses.
  - b. Complete a set of elective courses.
  - c. Pass a Qualifying Examination conducted by a committee of ISE faculty members.
  - d. Pass a Performance Review conducted by the ISE Faculty.

These requirements remain incomplete until deemed to be completed by the ISE Director of Graduate Studies (DGS) and confirmed by the ISE Faculty.
2. Dissertation Requirements:
  - a. Form a doctoral committee.
  - b. Pass a Dissertation Proposal Defense conducted by the doctoral committee.
  - c. Pass a General Examination conducted by the doctoral committee.
  - d. Pass a Dissertation Defense conducted by the doctoral committee.

These requirements remain incomplete until a student passes the Dissertation Defense and submits an approved dissertation signed by all doctoral committee members to the RCEAS.
3. Additional Requirements:
  - a. Submit annual progress reports to the ISE DGS.
  - b. Any additional Ph.D. degree requirements specified by the RCEAS and Lehigh.

Throughout this document, “the program” refers to the ISE Ph.D. program. In addition, the (expected) times of completion of requirements that are mentioned throughout the document are presented with full-time students in mind. The (expected) times of completion of requirements by part-time students are determined based on a customized program of study developed in consultation with the ISE DGS.

## Department Requirements

### Courses and Credits

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 program or has obtained prior approval from the ISE DGS to take the course at another time.

1 <sup>st</sup> year Fall Semester	Course Title (# Credits)
ISE 401	Convex Analysis (3)
ISE 406	Introduction to Mathematical Optimization (3)
ISE 429	Stochastic Models and Applications (3)
1 <sup>st</sup> year Spring Semester	
ISE 402	Applied Models in Operations Research (3)
ISE 417	Nonlinear Optimization (3)
ISE 418	Discrete Optimization (3)
2 <sup>nd</sup> year	
ISE 407	Computational Methods in Optimization (3)
ENGR 430	Technical Writing for Engineers and Scientists (1)

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

- the 8 Ph.D.-level core courses listed above and
- 5 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 doctoral students. In terms of 400-level ISE courses, students should consult with the ISE DGS about which are considered to be Ph.D.-level. (The determination is made by the instructor of the course, who informs the ISE DGS.) An elective (i.e., non-core) course can alternatively be taken in another department at Lehigh. In the case when a student wishes to use a course outside of ISE to cover an elective course requirement, the student must obtain approval from the ISE DGS and their research advisor prior to registering for the course.

**Readings courses:** A “Readings” (i.e., ISE 461) course cannot be used to cover any of these course requirements without prior approval from the ISE DGS. Approval must be obtained before the student registers for the course.

**Credit requirements:** For students who enter Lehigh with a master’s degree, completion of the Ph.D. degree requires an additional 11 credits, beyond the 37 credits mentioned above, totaling 48 credits. Those entering without a master’s degree need to complete an additional 35 credits, beyond the 37 credits mentioned above, totaling 72 credits. These credits can be obtained via courses (subject to the rules stated in this document) and/or dissertation (ISE 499) credits.

**Preparatory courses:** In case a student lacks the background necessary to pass a core or elective course, the student may seek approval from the ISE DGS to take a preparatory course that is below Ph.D.-level. The credits for such a course may be used to fulfill the Ph.D. course requirements with prior approval from the ISE DGS. Students must seek these approvals prior to registering for the preparatory course.

**For students who have taken a course at another institution equivalent to a core course:** If a student has completed 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 for this core course by successfully passing an examination by an instructor of the Lehigh core course. Note, however, that in this case the student will not receive credits for the course and this does not reduce the number of credits required for the degree. 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 program, then these can be used to fulfill Ph.D. *course* requirements if approval is granted by the student’s research advisor and the ISE DGS. Note, however, that this does not reduce the number of *credits* required for the degree.

**Course grade requirements:** Grades in all courses are expected to be at the level of B- or higher. If a student receives a grade lower than B-, then this will likely result in remedial action, such as the student needing to retake the course until a grade of at least B- is obtained. The grades expected in particular courses and the overall level of performance in courses are subject to the discretion of the ISE faculty.

## Qualifying Examination

Following the final exam period at the end of a student’s first Spring semester in the program, the student is expected to take the Qualifying Examination. (The exam may be delayed until the student’s second year in the program with prior approval from the ISE DGS. Approval should be sought at least one week prior to the exam start date.) The purpose of the exam is to:

1. Test the student’s knowledge of Industrial and Systems Engineering topics.
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 content from the program’s core courses.

Each student taking the exam at the same time is presented with the same three (sets of) open-ended questions. Over a two-week period, each student is to study the questions and prepare a written report and an oral presentation with the student's answers to be presented to a committee of three ISE faculty members, which will be determined prior to the exam start date. These faculty members assess the student's performance using an evaluation form that will be made available to the students prior to the exam start date. The results of the exam are either pass or fail.

Passing the Qualifying Examination is necessary for passing the Performance Review (see below). Two failures of the Qualifying Examination will lead to failure of the subsequent Performance Review.

## **Performance Review**

At the end of a student's first Spring semester in the program and after every subsequent Spring semester until it is passed (unconditionally), a Performance Review of the student will be conducted by the ISE faculty. Performance will be assessed based on:

1. Evaluation of courses completed and grades received.
2. Evaluation of Qualifying Examination results (if applicable).
3. Evaluation of progress toward developing a research program.
4. Other input as deemed relevant by the ISE 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 Performance Review has been completed successfully. A conditional pass indicates that the student may continue in the program, subject to certain stated conditions being fulfilled within a specified timeframe. These conditions may include, but are not limited to, (re)taking the Qualifying Examination, writing a research report, completing specific coursework, or achieving a minimum GPA during subsequent semesters. All of the conditions that must be fulfilled and the specified timeframe in which they must be fulfilled will be written out explicitly for the student at the time of the conditional pass. A fail will result in a student's dismissal from the program, after which the student may petition to transfer to a master's degree program.

If a student only conditionally passes a Performance Review, then a student may request that a subsequent review take place directly following completion of all required conditional actions. When a student feels that the conditional actions have been completed, the student should notify the ISE DGS and request a review. The ISE DGS may also call for a review to take place as deemed appropriate.

## **Completion of Department Requirements**

Once a student has completed the core and elective courses and passed the Qualifying Examination and Performance Review, the student should request a review by the ISE DGS. If the ISE DGS deems that the student has completed the Department Requirements, then the ISE DGS will confirm with the ISE Faculty that these requirements have been completed. The student will be notified if/when it has been confirmed.

## **Dissertation Requirements**

### **Formation of Doctoral Committee**

Each student is required to identify a research advisor, identify a dissertation topic, and form a doctoral committee subject to the approval of the student's research advisor; see the RCEAS Graduate Student Handbook for information about guidelines and restrictions about the formation of this committee. It is expected that the committee will meet at least annually to assess the student's performance and progress. Such meetings may be in concert with the required milestones described in the next three sections and/or may be conducted separately.

## **Dissertation Proposal**

The Dissertation Proposal is a written document that must be submitted to the student's doctoral committee and defended during an oral examination. The required written proposal should be submitted to the student's doctoral committee at least one week prior to the oral presentation date. The subjects of the proposal and presentation during the defense are the research that the student has conducted so far and the research that the student proposes to complete for the student's dissertation. The result of the defense is determined by the student's doctoral committee, and is either pass or fail. If a student fails the defense, then it may be rescheduled as many times as offered by the student's doctoral committee. A student is required to pass the Dissertation Proposal Defense prior to Admission to Candidacy; see the RCEAS Graduate Student Handbook.

## **General Examination**

The General Examination involves written components and an oral presentation. A preliminary draft of the student's dissertation is required, and should be submitted to the student's doctoral committee at least a few weeks prior to the oral presentation date. The doctoral committee submits a set of questions to the student, which are usually related to the topics in the student's dissertation draft. The student prepares answers to the committee's questions prior to the oral presentation date. (It is expected that the student would be given approximately two weeks to prepare answers to the committee's questions.) The subjects of the oral presentation should include a summary of the research that the student has conducted so far, the student's answers to the committee's questions, and a summary of the research to be completed for the student's dissertation. A written report on the student's answers to the committee's questions may also be required. The result of the exam is determined by the student's doctoral committee, and is either pass or fail. If a student fails the exam, then it may be rescheduled as many times as offered by the student's doctoral committee. A student is required to pass the General Examination in order to obtain a Ph.D. degree; see the RCEAS Graduate Student Handbook for guidelines and restrictions on the timing of a student's General Examination.

## **Dissertation Defense**

The Dissertation Defense requires a written dissertation and an oral presentation. The required dissertation should be submitted to the student's doctoral committee at least a couple of weeks prior to the oral presentation date. The subjects of the oral presentation are the contents of the student's dissertation. The result of the defense is determined by the student's doctoral committee, and is either pass or fail. If a student fails the defense, then it may be rescheduled as many times as offered by the student's doctoral committee. A student is required to pass the Dissertation Defense in order to obtain a Ph.D. degree; see the RCEAS Graduate Student Handbook for further guidelines and restrictions related to the defense.

## **Completion of Dissertation Requirements**

Once a student has passed the Dissertation Proposal Defence, General Examination, and Dissertation Defense, and has obtained an approved dissertation signed by all of the student's doctoral committee members, the student must submit their approved dissertation to the RCEAS in order to obtain a Ph.D. degree; see the RCEAS Graduate Student Handbook for instructions on this process.

## **Additional Requirements**

### **Annual Progress Reports**

Toward the end of every Spring semester, each student in the program is required to submit a progress report to the ISE DGS. In this report, the student provides a summary of progress over the prior calendar year, including: a list of courses taken and corresponding grades received; papers submitted, accepted, and/or published; and milestones (i.e., Qualifying Examination, Performance Review, Dissertation

Proposal, General Examination, and/or Dissertation Defense) passed. A student must also submit a final report to the ISE DGS prior to any non-Spring graduation date.

### **Students without a Research Advisor or Doctoral Committee**

If, at any point in time after a student has completed the Department Requirements, the student is without a research advisor or doctoral committee, then oversight of the student's progress is the responsibility of the ISE DGS. In such cases, the ISE DGS will advise the student in finding a research advisor. If the student is unable to find a willing research advisor, then the student will be dismissed from the program, after which the student may petition to transfer to a master's degree program.