

DEGREE REQUIREMENTS FOR THE Ph.D.  
DEPARTMENT OF INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH  
UNIVERSITY OF CALIFORNIA AT BERKELEY  
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The Department of Industrial Engineering and Operations Research offers two doctoral degrees: Ph.D. in IEOR, and D.Eng. in I.E. There is some difference between the two degrees in the nature of an acceptable dissertation, but all other degree requirements are the same. For students specializing in a particular area and/or working with particular faculty members, acceptable programs may be more tightly structured, as determined by the faculty involved. Course numbers are for courses within this Department; consult the General Catalogue for course descriptions. Excluded here are University requirements regarding registration and residence.

### **Course Requirements**

Doctoral students are required to complete at least nine IEOR graduate courses prior to graduation. The set of courses must include **IEOR 262A** (Mathematical Programming I) and at least **one additional course from Group A**, **263A** (Applied Stochastic Processes I) and at least **one additional course from Group B**, and at least **two courses from Group C**:

#### **Group A - Optimization**

262B (Mathematical Programming II)  
264 (Computational Optimization)  
266 (Network Flows and Graphs)  
269 (Integer Programming and Combinatorial Optimization)

#### **Group B – Stochastic Modeling**

263B (Applied Stochastic Processes II)  
267 (Queueing Theory)  
268 (Applied Dynamic Programming)  
261 (Experimenting with Simulated Systems)

#### **Group C – Modeling and Applied Operations Research**

215 (Analysis and Design of Databases)  
220 (Economics and Dynamics of Production)  
250 Introduction to Production and Logistics Models  
251 (Facilities Design and Logistics)  
253 (Supply Chain Operations and Management)  
268 (Applied Dynamic Programming)  
254 (Production and Inventory Systems)  
221 Introduction to Financial Engineering)

*In addition, many occasionally offered 290 courses fit into this category (290A, 290R, etc) – check with the head graduate advisor about specific courses.*

Advanced undergraduate courses in Linear Algebra and Real Analysis (equivalent to Math 110 and Math 104) are prerequisites for the PhD program. Students who have not taken these courses prior to entering the graduate program are required to do so during their first year.

Students in the doctoral program are strongly encouraged to take eight courses (four per semester) their first year in the graduate program.

### **The Doctoral Entrance Examination**

Every doctoral student is required to take the Doctoral Entrance Examination. Students entering without an MS degree are required to complete all MS degree requirements, and may do so by completing the MS course requirements and passing the Doctoral Entrance Exam.

The Entrance Examination consists of three parts:

(1) An optimization exam: Students are required to take 262A and at least one other course in Group A to be prepared for this exam.

(2) A stochastic processes exam: Students are required to take 263A and at least one other course in Group B to be prepared for this exam.

(3) An exam on modeling and applied operations research: Students are required to take two courses in Group C to be prepared for this exam.

The Entrance Examination will be offered near the end of every spring semester, approximately two weeks before finals. Passing the Entrance Examination is based on both superior performances on all parts of the exam, and on previous coursework. Students are required to take the entire exam at the same time. In order to take the exam, students are expected to perform sufficiently well in their first year courses. During the middle of the spring semester, a faculty committee will review the performance of first year doctoral students, and students who have performed sufficiently well on their coursework so that a superior performance on all parts of the exam will lead to passing will be permitted to take the exam.

All students who would like to be considered for the doctoral program are expected to take this exam no later than their third semester in this Department. In particular, students who enter in the fall are expected to take the exam at the end of the spring semester in the same academic year.

### **Program of Study; Major and Minor Requirements**

Some students have specific research interests and goals when they enter a doctoral program; for others, these interests develop in the process of taking courses and preparing for the Entrance Examination. In either case, it is imperative that students begin their research as soon as possible after completing their Entrance Examination. One of the important initial steps in this process is finding a faculty member who will agree to supervise the dissertation (Thesis Adviser). Every

student is required to complete at least one unit of independent study with a faculty member each semester after passing the Entrance Examination until finding a Thesis Adviser.

A minimum of nine graduate courses are required in the major, including those taken prior to the Entrance Examination. Usually, these are courses taken in this Department, but to a very limited extent, courses taken in other departments or at other institutions may be counted as part of this requirement. These courses should provide depth in the student's probable research area.

In addition, course work is required in two minor areas. This is a College of Engineering requirement, which specifies that "two or three courses (of advanced undergraduate or graduate level) typically represent a minimum program for a minor." This loose wording reflects the diverse needs of the College. In this Department, each minor must consist of six units at the graduate level, at least three of which must be taken for a letter grade. A minor may serve either to strengthen theoretical foundations (e.g., measure-theoretic probability theory), or as an area of application (e.g., transportation). At least one minor is to consist of courses outside of this Department. Both minors should be selected to strengthen the student's background in his or her research area. Graduate courses at other institutions may make up part of a minor if the subject matter is appropriate.

The Thesis Adviser, once known, should be consulted about all matters regarding the program of study.

### **The Qualifying Examination**

The Qualifying Examination is a written and oral examination administered by four faculty members. Three of these faculties members are required to be IEOR faculty members and the fourth committee member must be from outside the department, and have expertise in one of the student's minor areas of study. Students are expected to take the Qualifying Exam within one calendar year after completing the Doctoral Entrance Exam. Although it is necessary for a student to identify a potential research area and some potential dissertation topics in order to complete this exam, it is not necessary for the student to do a substantial amount of research in the area of the examination.

Prior to the exam, the student is required to identify a research area (broadly defined) in which he or she will be able to demonstrate expertise during the oral part of the examination. In addition, the student must be prepared to demonstrate expertise in one minor field. The objective of the exam is to assess the student's ability to demonstrate knowledge in a broad research area, and to identify potential research topics within this area.

At least two weeks prior to the exam, the student must submit his or her Qualifying Exam Report, to the qualifying exam committee. This report should be in the form of a research proposal, and should include both a substantial survey and critical evaluation of the literature in the likely area of the dissertation, and a potential research agenda in this area. If the student has completed preliminary research in this area, it is also appropriate to include a report of this research in this document. However, preliminary results are not required, and cannot make up the bulk of the document.

At least six weeks prior to the approximate date of the Qualifying Examination, the student needs to begin to arrange for Graduate Division approval of the exam committee. The student needs to pick up the appropriate form from the Student Affairs Officer. Once the date and the exam committee are decided upon, the student must also request a room in which the exam can be held.

The student must also prepare a white Program of Study card that includes all major and minor courses taken or planned, whether or not they are included in the syllabus, and lists the faculty members who will serve on the exam committee. Both the Graduate Division's "Application for Qualifying Examination" form and the Program of Study card must be approved and signed by the Head Graduate Advisor at least three weeks before the exam date.

The Qualifying Exam document will be reviewed by the three professors who represent the major on the student's Qualifying Examination Committee, to determine adequacy of preparation for the research area. For students who follow these guidelines and the recommendations of the Graduate Adviser and Thesis Adviser, this usually results in quick approval. However, if preparation is judged to be inadequate, they may recommend additional course work and postponement of this Examination.

In many departments, including ours, it has been the practice for students to schedule their own Qualifying Examinations. This exam is to be scheduled for three hours, at a time when all Committee members can attend.

The oral portion of the Qualifying Examination has two parts. In the first part, the student presents a 45-minute talk based on his or her Qualifying Examination Report. The Committee will ask questions pertaining to the report and presentation at this time. During the second part of the oral examination, the committee will ask more general questions to determine the student's level of expertise in the broadly defined research area specified by the student (and described in the syllabus). During this time, the outside committee member will also ask questions about one of the student's minor areas.

If the student's performance is judged to be unsatisfactory, the Committee may recommend reexamination, possibly after additional preparation has been completed. If the reasons for the unsatisfactory performance are judged to be major and fundamental, the Committee may recommend that a second attempt be denied.

### **Advancement to Candidacy**

After passing the Qualifying Examination, the student should file an application for Advancement to Candidacy, which sets up a three-person Guidance Committee for the Dissertation. Once this is approved, the student is eligible for reduced fees.

### **Dissertation Workshops and Dissertation Defense Workshop**

At least once a year after passing the qualifying examination, the student is required to hold a dissertation workshop. Each Dissertation Workshop has two primary objectives: (1) It provides the Department an opportunity to review the progress of students who have passed the Qualifying Examination, toward completion of their Doctoral Dissertation. (2) It facilitates interaction between the student and the Dissertation Committee and provides the basis for useful and consistent guidance. While the Dissertation Committee is primarily responsible for providing guidance, feedback from other faculty and from students is sought as well.

During the Workshop, the candidate is expected to present a prospective of, and results from, the dissertation research. Dissertation Advisers should advise students about the appropriate time for the Workshops. However, initiation of the Workshops is the student's responsibility. The student needs to notify the Department at least one month in advance of the desired Workshop date, and coordinate this date with the Dissertation Committee. At least two weeks prior to each Workshop, the student shall distribute to the Dissertation Committee a report called the Dissertation Prospectus. Announcement of the Workshop will be made through all the channels used to announce Departmental Seminars.

Each workshop is divided into two parts. The first part is devoted to a public presentation by the student and subsequent discussion. This part is conducted as a seminar and is open to all faculty and students. Graduate students and faculty who have research interests that relate to the Workshop are encouraged to attend; this may be their best opportunity to provide constructive feedback to the candidate. (Graduate students who have not yet reached this stage in their own program often find that participating in workshops is a valuable educational experience.) The Dissertation Committee moderates the presentation and discussion, controls the asking of questions by the audience, and calls an end to the first part of the Workshop.

In the second part of the Workshop, which immediately follows the public presentation, the Dissertation Committee and other interested faculty members will reconvene in private with the candidate for the purpose of giving more feedback and specific guidelines for continuing research. At this time, the Committee may decide that the candidate's progress is unsatisfactory. Should the Committee reach this conclusion, it will be reported in writing, with proper justification, to the candidate and the Department Chairman. The committee may require an additional workshop sooner than one year after the unsatisfactory one. Recurrent failure to present a satisfactory Prospectus Workshop may result in disqualification of the student and termination of Doctoral Candidacy.

Once the candidate has completed his or her research and completely written the thesis, a Defense Workshop must be scheduled and held. A completed copy of the thesis must be distributed to the committee at least two weeks before this final workshop. This workshop will follow the same format as other workshops. The committee will inform the candidate about any remaining problems or issues with the thesis. If the committee has serious issues with the thesis, they may require an additional defense workshop.