Ph.D Handbook

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Operations Research and Information Engineering

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I.   Major and Minor Subjects

All Ph.D. students in the Field of Operations Research major in the subject Operations Research and minor in at least two more subjects that can include Probability and Statistics, Mathematical Programming, Applied Mathematics, Computer Science, etc.

II.   Course Requirements

The following requirements cover the **first four semesters of Ph.D.-level work**, during which your primary goal should be to obtain broad exposure to the discipline of Operations Research. These requirements are intended to provide such academic breadth.

A. Core Courses

ORIE 6300*	Mathematical Programming I
ORIE 6500*	Applied Stochastic Processes
ORIE 6700*	Statistical Principles
MATH 4130**	Introduction to Analysis
MATH 4330**	Introduction to Algebra (emphasis on proof-based linear algebra)

*Depending on background, a student may be allowed to bypass one or more of ORIE 6300, 6500, 6700. In each such instance, however, the student is still required to take the final examination at the end of the first semester of study; these final examinations become a part of the student's Qualifying Examination (discussed later). On the other hand, if, for any course among these three, a student is not academically prepared to take the course during the first semester of study, it may be delayed until the third semester, with an appropriate preparatory course taken during the first year.

**Whether a student should take MATH 4130 and/or 4330 is determined by the student in consultation with a designated Field member prior to the beginning of the first semester of study.

B. Advanced Courses

- Students must perform well **(A- or better)** in **three** advanced Ph.D. courses with one course from **three** of the following four areas:

Research Area	Course Numbers
Applied Operations Research	61XX and 71XX
Mathematical Programming	63XX and 73XX
Probability	65XX and 75XX
Statistics	67XX and 77XX

- As a general rule, 6000-level ORIE courses, i.e., Ph.D.-level electives, are used to satisfy this requirement. With DGS approval, courses from other departments may also be used to meet this requirement.

C. Computer Literacy

- Each Ph.D. candidate must demonstrate computer literacy by taking an appropriate Ph.D.-level course.
- This course may simultaneously satisfy another requirement; e.g., the simulation course ORIE 6580 would both establish computer literacy and fulfill an Applied Operations Research advanced course requirement (provided you receive at least an A- in the course).

D. Course Load

- In each of the first **two** semesters you are expected to enroll in at least three appropriately sophisticated, technical courses, each with adequate provision for evaluating student progress, e.g., through regularly scheduled lectures, homework assignments, and/or examinations.
- Technical means courses in engineering, mathematics, or science, in addition to certain areas of business, such as quantitative finance or operations management.
- Appropriately sophisticated means either at Ph.D.-level or at a level appropriate to a student's background.
    - For example, someone who has taken an undergraduate class very similar to MATH 4130 should not enroll in this course, unless the former class was taken several years earlier – see **II.A.** note about consulting with a designated Field member.
- In the **third and the fourth** semester you are expected to enroll in at least two appropriately sophisticated, technical courses as well as engage in research.

E. Exceptions

- Any deviation from the above requires the written approval of the Field's Director of Graduate Studies (DGS). For example:
    - The computer literacy requirement may be fulfilled by completion of an appropriate project supervised by a Field member. These conditions *must* be met:
        1. The supervising Field member must agree to the arrangement.
        2. Before beginning, you must submit a one-to-two-page project proposal to the DGS.
        3. The DGS consults with appropriate Field faculty and will decide whether the project meets this requirement.
        4. At the completion of the project, the supervising Field member submits to the DGS written certification that the work accomplished in the project meets the computer literacy requirement.

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- DGS approval is required for courses from other departments used to satisfy the Advanced Courses requirement. For example:
  - Several appropriate Ph.D.-level probability courses are offered by the Department of Mathematics.
- Exceptionally well-prepared students beginning serious research investigation under the direction of a Field faculty member may seek DGS approval for using the course ORIE 7900 Special Investigations in satisfying the course load requirement.
  - The research project must be documented (at the beginning) by a student proposal approved by the supervising faculty member and (at termination) by a report from the faculty member on the work accomplished.

III. Minor Subjects and the Special Committee

- Each student forms a Special Committee **no later than the fourth semester**, although the composition of the committee may be changed at a later date.
  - Your Special Committee will be formalized in Student Center.
- Your Special Committee will consist of at least three individuals:
  - The Chair, who will ultimately be your thesis advisor.
  - The Minor Advisors, at least one for each of your two minor subjects (see below).
    - You are welcomed and encouraged to have more than one advisor for your minor subjects.
- Minors must be taken in engineering, science (including mathematics), or technical areas of business (e.g., finance).
  - You may petition for an exception.
- Of a student's two minor subjects, *at least one* must be from outside the Field of Operations Research.
- A minor subject typically involves three Ph.D. courses—sometimes four—determined by the minor advisor in consultation with the student.
- Required courses can count toward a minor; for example, OR&IE 6300(630) can count towards a minor in Mathematical Programming.
- The role of each minor subject is to enhance the student's exposure to the subject, either in breadth or in depth, beyond the courses that would generally be included as part of the student's major program of study.
  - At least one minor should be entirely satisfied by courses different from those used to satisfy the course requirements for the Ph.D. program.
  - No course may be used to count simultaneously toward both minors.

IV. Examination Requirements

There are three mandatory examinations over the course of your Ph.D. program.

A. Qualifying Exam

- The Qualifying Exam (QE) is the only exam that is Field-administered, as opposed to being administered by the Special Committee.
  - The QE determines whether you can be expected to perform at an appropriately high level in advanced coursework and research, and assists the Special Committee in developing your program of study.
- The QE for *all* Ph.D. students includes an oral presentation on a research paper selected from a collection submitted by Field members.
  - This presentation will be given at the beginning of your third semester.
  - At least three Field members (appointed by the DGS) will attend, and they may ask questions related to the content of the paper during the presentation.
  - The DGS determines what paper is assigned based on preference-order rankings you will submit in your third semester. Only one student will present any given paper, so you may be given your second or third choice.
  - Once the paper is assigned, you will be told which Field member submitted the paper for consultation purposes, though you should bear in mind that your independence in mastering the paper is also being evaluated.
- What constitutes the rest of your QE depends on your performance in the three primary ORIE courses.
  - You will be orally examined on the material of each of the three primary courses – ORIE 6300(630), 6500(650), 6700(670) – *for which you receive a grade of B+ or less*.
    - For courses taken during your first year, the oral exam is held at the beginning of the third semester.
    - For courses taken during your third semester, the oral exam is held at the beginning of the fourth semester.
    - Each course will have a separate day for its oral examination.
  - If you are permitted to skip one of these courses, the grade is based only on your performance on that course's mandatory final examination.
  - After a student has completed all of the required oral exams, but in any case no later than the beginning of the fourth semester (and generally at the beginning of the third semester), Field members discuss the student and reach one of two decisions, thus finalizing the Qualifying Exam:
    - You may continue in the Ph.D. program.
    - You will be required to leave the Ph.D. program at the end of the second year, retaining all funding and with support from faculty in pursuing alternative programs.
      - This outcome is relatively uncommon, but when it does occur, the student typically completes a master's thesis and receives a master's degree.
  - The decision of the Field takes into account *all* relevant materials such as performance in all courses and evaluations by Field members who have had an opportunity to assess the student's research promise.
  - In rare circumstances, the special committee may ask the student to retake the exam. The committee will determine the parameters of the retake in consultation with the DGS and communicate them clearly to the student.

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B. Admission to Candidacy Exam (The A Exam)

- This exam is a formal requirement of the Graduate School.
  - Because the Special Committee often views passing your QE as demonstrative of your competence in the fundamentals of the Field, the A exam focuses instead on assessing your mastery of your areas of research.
- It will typically be taken during your third year, and will be administered by your Special Committee (see Topic III above).
  - At the time of your exam, you must submit to the DGS a summary of the courses used to satisfy all program requirements.
  - In the rare event that not all coursework has been completed at this time, you will need to specify your intended courses for satisfying these requirements.
- The format of the A exam is largely up to the discretion of your Special committee – in some cases, it is primarily a presentation of proposed research for a thesis, for others, it may follow the format of an oral examination.
  - Your Special Committee will be available for consultation on what you should expect in your A Exam.
- A degree cannot be awarded until at least two units of residence have been earned after passing the exam.
- There will be at least three examining members of the Graduate School present at your exam.
  - The DGS will ensure this many will be present if one or more members of your Special Committee are unavailable.
  - Any member of the Field *may* attend your exam.

C. Final Exam (The B Exam)

- This exam is your presentation and defense of your Ph.D. thesis.
- It will also be announced as an ORIE colloquium.

V. Student Progress Review

Beginning in your second year and for the duration thereafter, Ph.D. students are required to meet annually with their Special Committee and complete a **Student Progress Review (SPR)** through the Graduate School's online system.

These forms help track progress towards your degree, but also serve as a useful record for you to refer to throughout your program and in preparation for your post-graduate career planning.

A. Procedure

- Schedule an SPR meeting with your Special Committee's Chair.

- Complete and submit your portion of the SPR form at least ten days prior to your scheduled meeting.
  - It may be saved as a draft, but a final deadline will be communicated to you (typically in late November).
  - Upon submission, it will be sent to your Committee Chair.
  - Information and links can be found on the Graduate School website under "Academic Progress" > "Requirements" > "Student Progress Review".
- Discuss your progress/planning with your Committee Chair.
- They will submit their portion of the online form within the next two weeks. A final deadline will also be communicated to them.

VI. Financial Support

Financial support for Ph.D. students is provided through a combination of Fellowships, Teaching Assistantships (TA), and Graduate Research Assistantships (GRA). Every option will provide a stipend that covers housing and living expenses in Ithaca, a tuition waiver, and medical insurance. Many students also receive financial support during the summer semesters.

Full funding for Ph.D. students is guaranteed through the **fourth year**. If it appears that you will need a fifth year (or beyond), funding is available through the University, but can not be guaranteed. External fellowships are an excellent option in this situation.

A. Fellowships

- A Fellowship provides financial support with no requirement that the student teach or conduct research in a specific group.
- There are internal fellowships available for candidates nominated by the Field, including from Cornell University as a whole, the College of Engineering, and ORIE itself.
- Students are heavily encouraged to apply for external fellowships, and the Field will support those applications every way that they can.
  - It is the student's responsibility to understand and maintain their eligibility for the external fellowship.

B. Teaching Assistantship

- An appointment in support of teaching a particular course, supervised by the instructor of the course.
- There is not a teaching requirement for the program, but students are encouraged to have at least one semester of TAing – being able to teach a subject is a demonstration of mastery.

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- The Graduate School mandates that a student must average 15 hours of work per week, with no one week going over 20.
  - You may have an additional part-time job with your TAship, but it can not be more than five hours a week. It is a federal law that a full-time student not work more than twenty hours in a given week, this is a nonnegotiable limit.

C. Graduate Research Assistantship

- An appointment with the primary responsibility of conducting research related to the student's thesis.
- Supervised by the student's research advisor, though the supervisor may be different if the thesis is a collaboration between multiple faculty.
- The duties of a GRA vary depending on the research areas and project, but goals and expectations should be clearly laid out at the start of the semester.
  - While there is no specific hours-based requirement for GRAs, they are still not permitted to take on outside employment that schedules more than 8 hours per week.

VII. International Teaching Assistant Program

Any student accepted into the Ph.D. program has already demonstrated a very high degree of proficiency with the English language. But if you had to submit TOEFL/IELTS scores with your application, you will be asked to complete an additional assessment and possibly complete a supplementary class before you can assume full TA duties.

A. Oral Proficiency Interview

- If your TOEFL Oral/Speaking score is 28 or over, or your IELTS is 8.5 or up, the OPI is not required and you will be assumed able to take on full TA responsibilities.
- The interview itself takes between 15-30 minutes, with the shorter times typically seen in highly-proficient Graduates.
- The OPI doesn't just rehash what you did in your Oral/Speaking proficiency examination, it is geared towards assessing your proficiency specifically for *teaching*.
  - The ability to think on your feet and put complex interrelated concepts into words – *while answering a question* – is not something that is assessed in the TOEFL or IELTS, but those skills are very important in education.

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- If you are assessed at a lower proficiency than you expect, it is not a reflection of your general proficiency with the English language – it is a reflection of your readiness to teach in your second (or third, or perhaps even fourth) language. Teaching is difficult even in a first language; we want you to be as prepared as you can be.
- There are different levels of proficiency given after an OPI:
  - Advanced Low (& Up) (74%): No additional training needed, you're ready to assume the full duties of a TA including holding office hours and providing instruction.
  - Intermediate High (12%): You are able to TA, but will need to take ALS 5780 while you do it. The majority of these students will take ALS 5780 once before passing, after which they will be able to TA with no additional supplementation.
  - Intermediate Mid (14%): You will need to complete ALS 5780 before you can assume TA duties. If you were assigned a TAship in your first semester, you will still be able to perform tasks like grading and your funding will be secure, but you will not be able to become a full TA unless and until you pass ALS 5780.

B. ALS 5780

- A two-credit Satisfactory/Unsatisfactory class that is deliberately experiential and focused on improving oral English proficiency. It is highly interactive, and designed to give you many opportunities to practice English speaking skills.
- The specific course strategies include small group seminars, bimonthly conferences with instructors, audio journals, and teaching practica.
- The instructors and the team behind the program are well aware that their students are already taking on a heavy and complicated courseload – while the class *is* additional work, it is not meant to be burdensome. Taking the class, even concurrently with TAing, helps build skills that make your other classes easier.
- While the class is not mandatory, it is *very, incredibly, heavily recommended*. Electing not to take it if you are assessed as needing it will not reflect well on you and will impact your ability to take on the duties of a TA in the future.

VIII.   Recent Ph.D.-Level Course Offerings

In addition to the courses listed below, all Cornell students have the ability to take coursework outside of their area of study. You are encouraged to seek coursework within other departments, such as Computer Science, Statistics, or Computer and Electrical Engineering, among many others.

Our students also enroll in coursework outside of OR and their minor fields, and in any given semester, our PhD students may be taking anything from Introduction to Wines to Fencing.

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IX. University Resources

Cornell students are encouraged to make the most of their time with the University, and many resources are made available for students.

A. Career and Professional Development

Resource	URL
Careers Beyond Academia	https://gradcareers.cornell.edu/
Pathway to Success	https://gradschool.cornell.edu/pathways-success
Graduate Student Career Services	http://www.career.cornell.edu/students/grad/index.cfm
Taxes FAQ	https://www.dfa.cornell.edu/tax/students/studenttaxfaq
International Students and Scholars Office	https://globallearning.cornell.edu/
Student Health Plan	https://studenthealthbenefits.cornell.edu/plans/health/SHP/index.cfm
Students with Families Support	http://studentswithfamilies.cornell.edu/

B. Funding Opportunities

Resource	URL
Fellowships Offered by Cornell (Left Sidebar)	http://www.gradschool.cornell.edu/costs-and-funding/fellowships
Graduate Fellowship Database	https://gradschool.cornell.edu/pathways-success
Graduate Conference Travel Grants	http://gradschool.cornell.edu/forms
Child Care Grant Program	http://studentswithfamilies.cornell.edu/students-with-children/student-child-care-grant/
Office of Sponsored Programs Opportunity List	https://www.osp.cornell.edu/Funding/funding_opps.html
NSF Graduate Research Fellowships	https://www.nsf.gov/pubs/2016/nsf16588/nsf16588.htm
NDSEG Fellowship Program	https://www.ndsegfellowships.org/

C. Cornell-Specific Resources

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Resource	URL
Cornell Graduate School General Information	http://gradschool.cornell.edu/
Graduate School Resources	http://gradschool.cornell.edu/resources
Graduate School Policy and Regulations	https://gradschool.cornell.edu/pathways-success
Cornell Code of Academic Integrity	http://cuinfo.cornell.edu/aic.cfm
Health and Wellness	https://health.cornell.edu/services/counseling-psychiatry
Cornell Let's Talk (Drop-in Counseling)	https://health.cornell.edu/services/mental-health-care/lets-talk
Diversity and Inclusion in Engineering	http://www.engineering.cornell.edu/engdiversity/

D. Rules, Guidelines, and Policies

Resource	URL
Grievance Procedures	https://gradschool.cornell.edu/grievances- and-complaints
Title IX and Sexual Harassment Reporting	https://titleix.cornell.edu/
Cornell Policy 6.3 (Consensual Relationships)	https://titleix.cornell.edu/policy-6-3/
Cornell Policy 6.4 (Prohibited Bias, Discrimination, Harassment, and Sexual and Related Misconduct)	https://titleix.cornell.edu/policy-6-4-prohibited-bias-discrimination-harassment-and-sexual-and-related-misconduct/
Change in Special Committee	https://gradschool.cornell.edu/academic-progress/requirements-milestones/special- committees/changing-your-committee/
Student-Advisor Mentoring Guidelines	https://gradschool.cornell.edu/academic-progress/advising-guide-for-research-students-2020/
Responsible Conduct of Researchers	https://www.oria.cornell.edu/rcr/trainingRequirements.htm
Cornell Graduate School Forms	http://gradschool.cornell.edu/forms

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