## OPERATIONS  RESEARCH  CENTER  GENERAL  EXAMINATION

The General Examination is composed of subject requirements, a research-oriented paper and an oral examination. To assure uniformity of standards of judgment, all General Examinations are offered during the same time frame (at the end of spring term), and the entire faculty of the Operations Research Center discusses and reviews the outcome of each examination.

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*NOTE:*  **Students must form an Interdepartmental Committee <u>directly after</u> qualifying for the doctoral program and before preparing for the General Examination. The Interdepartmental Committee is a requirement of the Graduate School for anyone who is pursuing an interdepartmental degree. Instructions for forming an Interdepartmental Committee are available in the Interdepartmental Program syllabus.**

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<u>General Examination Committee</u>:  At the start of the spring term, a General Exam Committee must be formed for each student who is planning to take the General Examination.

- Each student has the opportunity to participate in the selection of his/her General Examination Committee by suggesting three faculty members, one of whom must be the RO paper advisor.

- The RO paper advisor will be the student's research advisor.

- The ORC Codirectors will review the faculty selections and make appropriate changes, if necessary.

Each student is required to meet with each member of his/her examining committee at the start of the Spring term. The purpose of these meetings is to provide information to help the student better prepare for the exam and to ensure that the student and members of the examination committee become acquainted prior to the oral exam.

In order to satisfy the general examination requirements, students must select one of these options:

(A) General Track, (B) Operations Management Track, (C) Networked Systems Track, (D) Analytics Track.

## A) General Track

### A.1. Subject Requirements:

- Students must take at least eight graduate level classes. Students need to have their classes approved by the ORC Codirectors.

- From the list below at least two of these subjects must be taken in optimization and at least one in OR modeling. Students must also take three courses in either applied probability or statistics in addition to two electives.

- These subjects must be taken by the end of the student's 6th semester and students must maintain a GPA of 4.5 or better.

**Optimization Subjects:**

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|---|---|
| 1.142J/15.094J | Robust Modeling, Optimization, and Computation |
| 6.7210J/15.081J | Introduction to Mathematical Programming |
| 6.7220J/15.084J | Nonlinear Optimization |
| 6.7230J/18.456J | Algebraic Techniques and Semidefinite Optimization |
| 15.083 | Integer Optimization |

**Applied Probability Subjects:**

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|---|---|
| 6.7700J/15.085J | Fundamentals of Probability |
| 6.7710 | Discrete Stochastic Processes |
| 6.7720J/15.070J | Discrete Probability and Stochastic Processes |

**Statistics Subjects:**

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|---|---|
| 6.7250 | Optimization for Machine Learning |
| 6.7800 | Inference and Information |
| 6.7810 | Algorithms for Inference |
| 6.7900 | Machine Learning |
| 6.7940 | Dynamic Programming and Reinforcement Learning |
| 6.7910J/9.520J | Statistical Learning Theory and Applications |
| 9.521J/18.656J | Mathematical Statistics: A Non-Asymptotic Approach |
| 15.095 | Machine Learning Under a Modern Optimization Lens |
| HA STAT 211 | Statistical Inference I |

**OR Modeling Subjects:**

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|---|---|
| 1.203J/15.073J, etc. | Applied Probability and Stochastic Models |
| 6.7240 | Game Theory with Engineering Applications |
| 6.7260 | Network Science and Models |
| 6.7930/HST.956J | Machine Learning for Healthcare |
| 15.072 | Advanced Analytics Edge |
| 15.094J/1.142J | Robust Modeling, Optimization, and Computation |
| 15.764.1J/1.271J/IDS.250J | Inventory Theory and Supply Chains |
| 15.764.2J/1.271J/IDS.250J | Revenue Management and Pricing |
| 15.777 | Healthcare Lab: Introduction to Healthcare Delivery in the US |

In addition to the subjects listed above, students must also satisfy the following two requirements:

**A.2.  Hands-on Experience** – This requirement can be satisfied in three ways, namely:

**Option 1**: The student engages in a summer internship (duration of at least 10 weeks) during which the student builds OR models that address a real-world application. The student submits (a) a brief one-two page report that outlines what has been done (to be submitted electronically via email), and (b) a letter from the internship supervisor outlining the extent to which OR models have been used to address a real-world application and the student's role in it.

*Note: Effective summer of 2023, all students will be required to register for Course 15.110 for 1 unit for the summer term in which they hold the internship.*

**Option 2**:  Undertake a "Hands-On" project with an ORC faculty member, either as part of a supervised research activity or an extra part of a regular subject.  The student and the faculty member should submit documentation of the project and the work he/she has performed.

**Option 3**:  The student completes, with at least a grade of "B", the course 15.777 Healthcare Lab: Introduction to Healthcare Delivery in the United States.

*Note: students taking this course may choose to NOT have it fulfill their Hands-on requirement if they would prefer to satisfy it via option 1 or 2.*

**A.3.  Research-Oriented (RO) Paper**:  The purpose of the RO paper is to give some indication or evidence of capability for doing research.

- Each second-year student's research advisor will serve as their RO paper advisor.

- The student chooses a topic for the RO paper, in consultation with his/her RO paper advisor.  The topic of the RO paper must be any suitable topic that has a research orientation. The RO paper can build upon current work, but it cannot have been submitted for publication prior to the student entering the ORC program.

- The RO paper should be written primarily by the student.  If the RO paper is co-authored by a Faculty member, the ORC requires a letter stating that the student is the primary author.

- The student must submit a one-page proposal outlining his/her plan for the RO paper to the ORC during the beginning of the spring semester, second year.

- The RO paper should be structured as if it were intended for submission. There is no formal length requirement.  A paper around 25 pages long using a 12pt font and 1.5 line spacing would be considered appropriate.

- The RO paper is due approximately **one week prior to the beginning of the General Oral Examination period**, and will be read by the student's General Examination Committee.

**A.4. Oral Examination**: The General Oral Examination consists of two parts:

- Presentation of the student's RO paper. (The suggested length is 1 hour including questions.)

- A critical presentation of one research paper related to the student's area of research chosen by the student's General Examination Committee approximately two months before the general examination date. The purpose of this part is to give the student the opportunity to be critical on the paper, but also present a constructive proposal and potential extensions in the area of the paper. (The suggested length of time of this presentation is 1 hour.)

The general examination is intended to be largely diagnostic of the student's capability of doing research, thinking critically and constructively about new research ideas and ability for making a clear presentation of technical matter. At the conclusion of the exam, the student's General Exam Committee will make a recommendation of the student's status to the ORC faculty for approval. This recommendation will either be that the student has completely passed the exam or may indicate a need for remedial work.

## B) Operations Management Track

- Requirements A.1, A.3, A.4.

- Requirement A.2 is satisfied **only** with Option 1, a summer internship, preferably while a student is at MIT, with a company related to Operations Management.

- Take 15.764.1 (Inventory Theory and Supply Chains) and 15.764.2 (Revenue Management and Pricing). These subjects can be counted towards the requirement of eight graduate level classes.

- Serve as a teaching assistant in two MBA courses, which relate to Operations Management or one MBA course and take another for credit. At least one of the courses the student is a teaching assistant for should be a course with recitations. The list of such classes includes: 15.060, 15.072, 15.761, 15.762, 15.763, 15.768, 15.769, and 15.783.

- The doctoral thesis of the student should be in a topic related to Operations Management and one member of the student's doctoral thesis committee, who should be among faculty from the ORC faculty list who specialize in Operations Management, will be responsible to approve whether the thesis topic connects to Operations Management.

## C) Networked Systems Track

- Requirements A.1, A.3, A.4.

- Requirement A.2 is satisfied only with Option 1, a summer internship, with a company related to Networked Systems, if possible.

- Take 6.7240 (Game Theory with Engineering Applications) and 6.7260 (Network Science and Models). These subjects can be counted towards the requirement of eight graduate level classes.

- Serve as a teaching assistant in either 6.7240 or 6.7260, or another adequate subject.

**D) Analytics Track**

- Requirements A.1, A.3, A.4.

- Requirement A.2 is satisfied **only** with Option 1, a summer internship, preferably while a student is at MIT, with a company related to Analytics.

- Take 6.7900 (Machine Learning) and 15.072 (Advanced Analytics Edge). These subjects can be counted towards the requirement of eight graduate level classes.

- Serve as a teaching assistant in 6.7900 or 15.072 or another approved subject related to Analytics.

- The doctoral thesis of the student should be in a topic related to Analytics and one member of the student's doctoral thesis committee, who should be among faculty from the ORC faculty list who specialize in Analytics, will be responsible to approve whether the thesis topic connects to Analytics.

## General Examination Timetable

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| **February 5 - 16, 2024** | **Meetings with Committee Members** |
| **March 4, 2024** | **One-page Research-Oriented proposal due** |
| **Week of March 4th** | **Student receives research paper to critique** |
| **April 8, 2024** | **Research-Oriented paper due** |
| **April 22 - May 8, 2024** | **Oral examination period** |