

Industrial and Systems Engineering Master of Science Program

Data Analytics and Data-Driven Optimization

Department of Integrated Systems Engineering
The Ohio State University
(Expected Duration: 3 Semesters)



Our society is undergoing a major transformation with the use of large-scale, diverse, and high-resolution data sets that allow for data-intensive decision-making and optimization. There is an imperative need for data analytics—means and methods for using large data sets and computer models to drive business value, understand human relationships, and improve decision-making. The powerful combination of big data analytics with optimization has been successfully demonstrated and will be increasingly needed in the management of:

- healthcare and transportation networks
- retail and financial decision making
- supply chain and logistics systems
- large scale information systems
- manufacturing operations
- energy and smart grids
- social networks.

The ISE Masters Program in Data Analytics and Data-Driven Optimization is designed to provide students with a strong background in analytics, data science, computer science and optimization methods. The track requires a sequence of courses in:

- computer science
- operations research
- cognitive engineering
- probability and statistics

Additional electives are also recommended in Business, Computer Science Engineering (CSE) and Industrial and Systems Engineering (ISE) and Statistics (STAT).

Students will be prepared in the use of critical tool sets necessary for managing, visualizing, and extracting useful information from big data, as well as powerful skill sets such for modeling, simulation, optimization and decision analysis in order to support efficient data-driven decision making.

Admission Requirements. Prior to admission, students interested in admission to this Masters Program should be proficient in the following areas¹:

- Vector calculus
- Computer programming (e.g., C, C++, Java)
- Calculus-based probability
- Probability-based statistics
- Linear algebra

Graduation Requirements. All Analytics Graduate Students must satisfy degree requirements defined in the Industrial and Systems Engineering Graduate Student Handbook (www.ise.osu.edu/docpdf/ISEGradHandbook.pdf).

To complete the ISE Masters Program in Data Analytics and Data-Driven Optimization, students must complete a total of 36 graduate credit hours. The course work consists of:

- 12 semester hours of ISE courses, 10 semester hours of CSE courses, 4 semester hours of STAT courses, and 3 semester hours of Visual Analytics (in total 29 credit hours)
- 2 semester hours of ISE 7883 (Department Seminar) and one 5000-level or higher ISE course in manufacturing or human factors, subject to approval of the advisory committee, in order to meet the ISE secondary sub-discipline requirement. (in total 5 semester hours)
- A project, exam or Masters thesis designed to meet the exit requirements of the Data Analytics and Optimization MS Program:
 1. M.S. students can meet the exit requirement by 1) doing a Masters thesis (4 units); or 2) earning a B or higher in a 5000- or higher- level Analytics elective course that is at least 2 units and has a project requirement; or 3) passing the M.S. Exit Examination.
 2. M.S. students who are not doing the thesis option and did not receive a B or higher in a 5000-level Analytics elective course with a project requirement may instead take the M.S. Exit Examination.
 3. The M.S. Exit Examination is administered annually during the week after Spring final examinations have been completed. Any ISE graduate student who achieves an overall GPA (including all graduate courses taken at OSU) of 3.00 is eligible to take the exam.

¹ Students without evidence of this material on their transcripts will have to demonstrate proficiency with the subject matter. This can be accomplished via appropriate coursework, at either the undergraduate or graduate level, to be determined in consultation with the academic adviser.

M.S. Exit Examination for ISE M.S. Analytics students

- M.S. students who are not doing the thesis option and did not receive a B or higher in a 5000-level Analytics elective course with a project requirement may instead take the M.S. Exit Examination.
- The M.S. Exit Examination is administered annually during the week after Spring final complete. Any ISE graduate student who achieves an overall GPA (including all courses taken at OSU) of 3.00 is eligible to take the exam. Those students who are planning to graduate in Fall should take the exam in the preceding Spring semester. The process to sign-up for the exam will be announced during Spring semester. Students intending to take the exam must sign-up before the announced deadline, so there is sufficient time to check that the grade eligibility requirement is satisfied.
- The intent of the exam is to verify that students are sufficiently well grounded in the “fundamentals of OR.” For example, the exam might cover the following topics:
 - **Optimization:** Integer and Linear Programming Formulations and Solution Methods; Linear Programming Theory and Duality; Complexity Theory; Convexity
 - **Stochastic Processes:** Random Variables; Probability Distributions; Conditional Probability and Expectations; Random Number Generation; Simulation Theory
 - **Statistics:** Parametric and Non-Parametric Hypothesis Testing; Distribution Fitting; Regression
- After the exams have been completed, the OR Faculty meet to discuss each student’s performance on the exam and performance in classes taken. Based on this, the faculty determine whether each student has “passed” or “failed” the examination.
- A student who has failed the examination, may be deemed eligible to retake it. Students who are deemed eligible to retake the exam must do so the next time that it is offered. No student will be eligible to take the exam more than twice.

The following course requirements focusing on data analytics and optimization:

Required Data Analytics and Optimization Courses (students who have previously completed the equivalent of these courses can select substitutes from the list of recommended electives):

- ISE (12 credit hours)
 - ISE 5110 Design of Engineering Experiments (3)
 - ISE 5200 Linear Optimization (3)
 - ISE 6300 Simulation for System Analytics and Decision-Making (3)
 - ISE 7250 Operations Research Models and Methods (3)
- CSE (10 credit hours)
 - CSE 5023 Software II (Java II) (3)
 - CSE 5241 Introduction to Database Systems (2)
 - CSE 5032 Foundations I: Discrete Structures (2)
 - CSE 5243 Introduction to Data Mining (3)
- STAT (4 credit hours)
 - Stat 6450 Applied Regression Analysis (4)
- Visual Analytics (3 credit hours)
 - One of the following –
 - ISE 5760 Visual Analytics and Sense Making² (3)
 - CSE 5544 Introduction to Scientific Visualization (3)

² ISE5700 is a prerequisite for ISE5760. ISE5700 can be used to fulfill the ISE secondary sub-discipline requirement.

Additional ISE Requirements

- Seminar (2 credit hours)
 - ISE 7883: Seminar (2)
- One 5000-level or higher ISE course in manufacturing, or human factors:
Recommended courses-
 - ISE 5682 Fundamentals of Product Design Engineering, or
 - ISE 5600 Principles of Occupational Biomechanics and Industrial Ergonomics, or
 - ISE 5700 Cognitive Systems Engineering

Possible project courses and recommended electives (students should check to make sure the course has a project requirement in the semester offered)

- ISE
 - ISE 6220 Network Optimization
 - ISE 6290 Stochastic Optimization
 - ISE 7100 Advanced Simulation
 - ISE 7210 Large-Scale Optimization
 - ISE 7230 Integer Optimization
 - ISE 7420 Sequencing and Scheduling
- CSE
 - CSE 5523 Machine Learning and Statistical Pattern Recognition (3)
 - CSE 5331 Foundations II: Data Structures and Algorithms (2)
 - CSE 5122 Data Structures Using C++ (3)
- STAT
 - PUBHBIO 7220 - Applied Logistic Regression
 - Stat 5740 Introduction to SAS Software (2)
 - Stat 6550 The Statistical Analysis of Time Series (2)
 - Stat 6740 Data Management and Graphics for Statistical Analyses (3)

Data Analytics Course Track

Autumn I	Credit Hours		Spring I	Credit Hours
ISE 5200 <i>Linear Optimization</i>	3		CSE 5023* <i>Software II (Java II)</i>	3
CSE 5241* <i>Intro to Database Systems</i>	2		ISE 7250 <i>OR Models & Methods</i>	3
ISE 5110 <i>Design of Engr. Experiments</i>	3		ISE 6300 <i>Simulation for System Analytics & Decision-Making</i>	3
STAT 6450+ <i>Applied Regression Analysis</i>	4		Visual Analytics (Choose 1) ISE 5760~ <i>Visual Analytics & Sense Making</i> or CSE 5544 <i>Data Visualization</i>	3
ISE 7883 <i>Department Seminar</i>	1		ISE 7883 <i>Department Seminar</i>	1
TOTAL	13		TOTAL	13

Autumn II	Credit Hours
ISE Secondary Sub-Discipline~	3
CSE 5243+ <i>Intro to Data Mining</i>	3
CSE 5032* <i>Foundations I: Discrete Structures</i>	2
ISE 5000 level or higher project course^ or thesis hours	2-4
TOTAL	10-12

Students should contact the ISE Graduate Program Coordinator, Amy Shaw Shaw.229@osu.edu, for a time to take completed course enrollment forms to the CSE and STAT Departments for signatures. **Students should not directly contact the Departments.**

+CSE 5243 & STAT 6450 are Autumn only courses

*CSE 5032, 5023, & 5241 are offered every semester, including summer session

~ One 5000-level or higher ISE course in manufacturing, or human factors:

Recommended courses-

- ISE 5682 Fundamentals of Product Design Engineering, or
- ISE 5600 Principles of Occupational Biomechanics and Industrial Ergonomics, or
- ISE 5700 Cognitive Systems Engineering (prerequisite to ISE 5760)

^ Possible project courses include (if they have a project requirement when offered):

- ISE
 - ISE 6220 Network Optimization
 - ISE 6290 Stochastic Optimization
 - ISE 7100 Advanced Simulation
 - ISE 7210 Large-Scale Optimization
 - ISE 7230 Integer Optimization
 - ISE 7420 Sequencing and Scheduling
- CSE
 - CSE 5523 Machine Learning and Statistical Pattern Recognition (3)
 - CSE 5331 Foundations II: Data Structures and Algorithms (2)
 - CSE 5122 Data Structures Using C++ (3)
- STAT
 - PUBHBIO 7220 - Applied Logistic Regression
 - Stat 5740 Introduction to SAS Software (2)
 - Stat 6550 The Statistical Analysis of Time Series (2)
 - Stat 6740 Data Management and Graphics for Statistical Analyses (3)

**Plan of Study Form:
Master of Science Degree in Industrial and Systems Engineering (ISE)
Data Analytics and Data-Driven Optimization Concentration**

Student Name (please print): _____

Required ISE Courses: A total of 12 credit hours in ISE are required.

*Students who have previously completed the equivalent of these courses can select substitutes from the list of recommended electives

Course	Title	Hours	Semester Taken
ISE 5110	Design of Engineering Experiments	3	
ISE 5200	Linear Optimization	3	Fall 1
ISE 6300	Simulation for System Analytics & Decision-Making	3	Spring
ISE 7250	Operations Research Models & Methods	3	Spring

Required CSE Courses: A total of 10 credit hours in CSE are required.

*Students who have previously completed the equivalent of these courses can select substitutes from the list of recommended electives

Course	Title	Hours	Semester Taken
CSE 5023	Software II (Java II)	3	
CSE 5241	Intro to Database Systems	2	Fall 1
CSE 5032	Foundations I: Discrete Structures	2	
CSE 5243	Intro to Data Mining	3	Spring/Fall 2

Required STAT Course: A total of 4 credit hours in STAT are required.

Course	Title	Hours	Semester Taken
STAT 6450	Applied Regression Analysis	4	Fall

Required Visual Analytics: Choose one 3 credit hour course

Course	Title	Hours	Semester Taken
ISE 5760	Visual Analytics and Sense Making	3	Spring
CSE 5544	Intro to Scientific Visualization	3	Spring

Additional ISE Requirements

Department Seminar: A total of two 1 credit hour courses are required.

Course	Title	Hours	Semester Taken
ISE 7883	Department Seminar	2	Fall 1, Spring

ISE Secondary Sub-Discipline: Choose 1 course.

Course	Title	Hours	Semester Taken
ISE 5682	Fundamentals of Product Design Engineering	3	
ISE 5600	Principles of occupational Biomechanics and Industrial Ergonomics	3	
ISE 5700	Cognitive Systems Engineering	3	

A project (minimum 2 credit hours), exam, or Master’s thesis (4 credit hours) designed to meet the exit requirements of the Data Analytics and Optimization MS Program.

Course, Thesis, or Exam	Title	Hours	Semester Taken
		2-4	Fall 2

	Approval Signatures	Date
Student:		
Advisor:		
ISE Graduate Chair:		

INSTRUCTIONS FOR STUDENT

The first step to complete this form is to arrange a meeting with your faculty advisor. You and your advisor will discuss a viable plan of study, complete the ISE MS Plan of Study form, and obtain your faculty advisor’s signature. You should also sign the form, and then seek an approval signature from the ISE Graduate Chair. A copy of this form should be provided to the ISE Graduate Coordinator to be placed in your graduate file in the ISE main office (210 Baker Systems). It is also your responsibility to provide a copy of the ISE MS Plan of Study form to your faculty advisor. ***The Plan of Study must be approved prior to registration for your second semester of study.***

If any significant changes to your Plan of Study are made as you progress through your program (e.g. substitute courses, change in primary or secondary sub-disciplines, etc.), it is your responsibility to seek formal approval of those changes from your faculty advisor. This can be done by writing-in the changes on the originally submitted ISE MS Plan of Study form, and obtaining the faculty advisor’s initials and date next to the changes. This form also serves as a convenient checklist for you, your faculty advisor, and the ISE Graduate Studies Chair to verify that all ISE MS program requirements have been met at the completion of your academic program.

You should submit your application to graduate through GradForms.osu.edu using your OSU username to submit an *Application to Graduate*. The deadline to approve graduation is the third Friday of the term (the application to graduate deadline includes both regular term and those planning to use the End-of-Semester deadline); students should apply far enough in advance to allow time for both the Faculty Advisor and the Graduate Studies Chair or Graduate Program Coordinator to approve the application. ***Application submission at least two weeks prior to the third Friday of the term is highly recommended.***

Finally, this form serves an archival record of what courses/credits you used to fulfill ISE MS program requirements. Extraneous courses can be identified by comparing the courses listed on this form with the full list of courses shown on your official transcript. Extraneous courses have the potential to be transferred to your doctoral program of study, if you decide to pursue that degree.