

Degree of Doctor of Philosophy in Management Science and Engineering

September 2011

The Ph.D. degree in MS&E is intended for students primarily interested in a career of research and teaching, or high-level technical work in universities, industry or government. The program requires three years of full-time graduate study, at least two years of which must be at Stanford University. Typically, however, students take about four to five years after entering the program to complete all Ph.D. requirements. The Ph.D. is generally organized around the requirement that the students acquire a certain breadth across some of the eight areas of the department, and depth in one of them. These areas are:

- Systems modeling and optimization
- Probability and stochastic systems
- Information science and technology
- Economics and finance
- Decision analysis and risk analysis
- Production and operations management
- Organization, technology and entrepreneurship
- Policy and strategy

Doctoral students are required to take a number of courses, both to pass a qualifying exam in one of these areas, or the Systems Program which is a combination of several areas, and to complete a dissertation based on research which must make an original contribution to knowledge.

Ph. D. Program

Each student admitted to the Ph.D. program must satisfy a breadth requirement and pass a qualification procedure. The purpose of the qualification procedure is to assess the student's command of the field and to evaluate his or her potential to complete a high-quality dissertation in a timely manner. The student must complete specified course work in one of the eight areas of the department, or the Systems Program which is a combination of several areas. The qualification decision is based on the student's coursework and grade point average (GPA), on the one or two preliminary papers prepared by the student with close guidance from at least two MS&E faculty members, the student's performance in an area examination, and an overall assessment by the faculty of the student's ability to conduct high-quality Ph.D. research. Considering this evidence, the department faculty will vote on advancing the student to candidacy in the department at large. The Ph.D. requires a minimum of 135 units, at least 54 of which must be in courses of 3 units or more (90 for students who have not previously completed an MS degree). At least 48 course units in courses of 3 units or more, and all courses used to satisfy breadth and depth requirements, must be taken for a letter grade. Finally, the student must pass a university oral examination and complete a Ph.D. dissertation. During the course of the Ph.D. program, students who do not have a Master's degree are strongly encouraged to complete one, either in MS&E or in another Stanford department.

Breadth Requirement

1. The breadth requirement is to be satisfied by a choice of four courses spanning four out of the above mentioned eight areas of the department. This may include the depth area. See in Appendix 1 the list of courses satisfying the breadth requirement.
2. The Ph.D. candidacy form must contain four courses that satisfy the breadth requirement.
3. Courses chosen to satisfy the breadth requirement must be taken for letter grades.
4. At least one of the four courses chosen to satisfy the breadth requirement must be at the 300 level.

Qualification procedure requirements

The qualification procedure is based both on breadth across the department's disciplines and depth in an area of the student's choice. The qualification process must be completed by the end of the month of May of the student's second year of graduate study in the department. The performance of all doctoral students will be reviewed every year at a department faculty meeting at the end of May or beginning of June. Ph.D. qualification decisions will be made at that time and individual feedback will be provided.

The Ph.D. qualification requirements comprise three elements:

1. Courses and GPA

Students must complete the depth requirements of one of the eight areas of the MS&E department or the Systems Program which is a combination of several areas (see in Appendix 2 the Ph.D. requirements for the 8 areas of the MS&E department). All courses used to satisfy depth requirements must be taken for a letter grade. Course substitutions may be approved by the doctoral program advisor or the MS&E dissertation advisor on the candidacy form or on a request for graduate course waiver/substitution form.

A student must maintain a GPA of at least 3.4 in the four courses chosen to satisfy the breadth requirements, and a GPA of at least 3.4 in the set of all courses taken by the student within the department. In both cases, the GPA will be computed on the basis of the nominal number of units for which each course is offered.

2. Paper(s)

A student may choose between two options. The first option involves one paper supervised by a primary faculty advisor and a faculty consultant. This paper should be written in two quarters. The second option involves two shorter sequential tutorials, with two different faculty advisors. Each tutorial should be completed in one quarter. In both options, the student chooses the faculty advisor(s)/consultant with the faculty members' consent. There must be at least two MS&E faculty members supervising and evaluating this requirement for advancement to candidacy.

The paper/tutorials must be completed before the Spring Quarter of a student's second year of graduate study in the department if the student's qualifying exam is during the Spring Quarter, and before the end of May of that year otherwise. A student may register for up to three units

per tutorial and up to six units for a paper. These paper or tutorial units do not count towards the 54 course units required for the Ph.D., and letter grades are not given.

3. Area qualification

In addition, during the second year, a student must pass an examination in one of the eight areas of the MS&E Department or the Systems Program which is a combination of several areas. The student chooses the area/program in which to take the examination. This area examination will be written, oral, or both at the discretion of the area faculty administering the exam. Most areas offer the qualifying exam only once per year, which may be early in the second year.

Degree Progress and Student Responsibility

Each student's progress will be reviewed annually by the MS&E faculty. Typically, this will occur at a faculty meeting at the end of Spring Quarter, and email notifications will be sent over the summer.

First year students should complete 30-54 units of breadth and depth courses, and develop relationships with faculty members who might serve as dissertation advisor and reading committee.

Second year students should complete most, if not all, of breadth and depth courses, work with two different MS&E faculty members on tutorials/research paper, and pass an area qualifying exam. Most areas offer the qualifying exam only once per year, which may be early in the second year. Students should continue to develop relationships with faculty members who might serve as dissertation advisors and reading committee, and select a dissertation advisor before the beginning of the third year.

Third year students should complete any remaining breadth and depth courses, select a dissertation topic, and make good progress on the dissertation.

Fourth year students should select a reading committee, and complete, or nearly complete, the oral exam and dissertation.

It shall be the responsibility of the student to initiate each step in completing the Ph.D. program. It is strongly recommended that each student, in the first year of graduate study at Stanford, make it a special point to become well acquainted with MS&E faculty members and to seek advice and counsel regarding possible Ph.D. candidacy. A faculty member will be more likely to accept the responsibility of supervising the research of a student whom he or she knows fairly well than a student whose abilities, initiative, and originality are almost unknown.

It is expected that advanced students will regularly report to their full Reading Committee on the progress of their dissertation. It is also expected that the student avail him/herself of the different expertise represented on the Committee continually. Each member of this Committee must certify approval of both the scope and quality of the dissertation.

The *Doctoral Dissertation Reading Committee* consists of the principal dissertation adviser and two other readers. At least one member must be from the student's major department.

As administered in this department, the *University Oral Examination* is primarily a defense of the dissertation; however, the candidate should be prepared to answer any question raised by any members of the Academic Council who choose to be present. Students should schedule three hours for the Oral Examination, which usually consists of a 45 minute public presentation, followed by closed-session questioning of the examinee by the committee, and committee deliberation. The University Oral examination may be scheduled after the Dissertation Reading Committee has given tentative approval to the dissertation. *The student must be enrolled in the quarter of their Oral Examination.*

The examining committee usually consists of the three members of the Reading Committee as well as a fourth faculty member and an Orals Chair. It is the responsibility of the student's advisor to find an appropriate Orals Chair. The Chair must be an Academic Council member and may not be affiliated with either the Department of Management Science and Engineering nor any department in which the student's advisor has a regular appointment. Emeriti Professors are eligible to serve as an Orals Chair. The student needs to reserve a room, and meet with the Student Services Manager to complete the Oral Examination Schedule and pick up other paper work. This paperwork, along with an abstract, needs to be delivered to the Orals Chair at least one week prior to the Oral Examination.

Appendix 1
Choice of courses satisfying the breadth requirement

Systems Modeling and Optimization

201	Dynamic Systems
211	Linear and Nonlinear Optimization
212	Mathematical Programming and Combinatorial Optimization
31x	Any 300-level course or seminar in optimization

Probability and Stochastic Systems

220	Probabilistic Analysis
221	Stochastic Modeling
223	Simulation
32x, 33x	Any 300-level course or seminar in probability, stochastic systems or simulation

Information Science and Technology

237	The Social Data Revolution: Data Mining and E-Business
239	Computational Advertising
33x	Any 300-level course or seminar in IST
EE 284	Introduction to Computer Networks

Economics and Finance

241	Economic Analysis
242	Investment Science
248	Economics of Natural Resources
34x	Any 300-level course or seminar in Economics and Finance

Decision Analysis and Risk Analysis

250 A	Engineering Risk Analysis
251	Stochastic Decision Models
252	Decision Analysis I: Foundations of Decision Analysis
35x	Any 300-level course or seminar in DA/RA

Production and Operations Management

26x, 36x	Any 200 or 300 level course or seminar in POM
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Organization, Technology and Entrepreneurship

280	Organizational Behavior and Management
38x	Any 300-level course or seminar in Organizations & Management

Policy and Strategy

270	Strategy and Technology-Based Companies
293	Technology in National Security
3xx	Approved doctoral courses and seminars in related departments

Appendix 2

Ph.D. course requirements for the research areas of the MS&E department

Systems Modeling and Optimization and Probability and Stochastic Systems Combined in a common Ph.D. program in Operations Research

The purpose of this area is to develop students who are skilled in the theory and algorithms of optimization and stochastic systems, and who can create the mathematical theory, algorithms and models needed to address significant problems arising in the planning and management of complex systems.

a. Prerequisites

ALL students are expected to be familiar with the material in Math 113 (Linear Algebra); Math 115 or 171 (Real Analysis); CS 106A or 106X (Programming); MS&E 220 or Stat 116 (Probability); MS&E 221 or Stat 217 (Stochastic Modeling or Stochastic Processes); and MS&E 241 or Econ 50 (Microeconomics).

In addition, the following courses are strongly recommended: CS 137 (Introduction to Scientific Computing); Stat 200 (Statistical Inference); and Stat 203 (Regression & Analysis of Variance).

b. Requirements

The course requirements consist of four core courses, and four additional courses. Students are expected to earn a letter grade of A- or better in all courses counted for the requirements. A student's plan for completing these requirements must be discussed with and approved by their Faculty Advisor by the beginning of Autumn Quarter of their second year.

CORE COURSES (*four courses*):

ALL students are required to take

MS&E 310	Linear Programming
MS&E 321	Stochastic Systems

In addition, students must choose TWO of the following THREE courses:

MS&E 311	Optimization (or EE 364A Convex Optimization I)
MS&E 316	Discrete Mathematics and Algorithms
Stat 310A	Theory of Probability

ADDITIONAL COURSES (*four courses*):

In addition to the core, students should take at least FOUR 3-4 unit courses in some coherent area of specialization.

The area of specialization may be methodological; examples include (but are not limited to) optimization, stochastic systems, stochastic control, algorithms, economic analysis, statistical inference, scientific computing, etc. The area of specialization could also have a significant modeling and application component, such as (but not limited to) information services, telecommunications, financial engineering, supply chains, health care, energy, etc. Independent of the choice of specialization, students are encouraged to take a range of courses covering methodology, modeling, and applications.

Any MS&E courses satisfying this requirement must be at the 300-level, while courses outside MS&E must be at a comparable level. (Note that these courses may also be counted towards the MS&E departmental breadth requirement.)

c. Qualifying Exam:

Students take the qualifying exam at the beginning of their second year of study.

The qualifying exam consists of two written exams: one in Optimization and one in Stochastic Systems. The first exam covers the material in MS&E 310 and related prerequisites. The second exam covers the material in MS&E 321 and related prerequisites.

d. Qualifying process:

The student will do two quarter-length tutorials with Operations Research faculty (or affiliated faculty). A written report approved by the supervising faculty member is required on each tutorial. In addition, at the end of the second year, students are expected to make a 30-minute presentation to the broader Operations Research faculty. The presentation must include original research or promising directions towards original research.

The student can do both tutorials with the same faculty member; in this case a single written report is sufficient, and the presentation can be of the two tutorials together.

Advancement to candidacy will be based on performance in the required courses, on the qualifying exam, and on the tutorials (both in the written report and in the oral presentation).

Information Science and Technology

I. Core Courses:

Students have to take at least 5 classes, from at least 4 different CORE areas. Students can substitute other 300-level classes (including those from other departments) from the same general area on a case-by-case basis, subject to approval by the student's program/dissertation advisor. The students must obtain a GPA of 3.5 or better in the core courses to qualify. The core courses must be completed in or before the spring quarter of the student's second year.

Core Areas:

- a) Optimization and algorithms
MS&E 212; MS&E 31x; MS&E 351; MS&E 339; CS 261
- b) Networks
MS&E 235; MS&E 238; MS&E 337; MS&E 335
- c) Economics and Game Theory
MS&E 246; MS&E 341; MS&E 344; MS&E 336
- d) Data analysis/probability
MS&E 32x; MS&E383; CS 229; STAT 310A; EDU316
- e) Behavioral sciences
MS&E371; MS&E380; MS&E381a; MS&E381b; MS&E384; Educ316; Soc314

II. Classes in a Focus Area:

Students must choose one of six FOCUS areas, and take at least four 300-level classes in this area. At most one class may be used to satisfy both group I and group II requirements. The list of classes must be chosen and approved (by the student's dissertation advisor) by the end of the second year, and these classes must be completed by the end of the student's third year. Any changes must be approved by the student's dissertation advisor.

Focus Areas:

- a) Social networks
- b) Information and computer networks
- c) Information economics
- d) Information services
- e) Algorithms and data analysis
- f) Performance engineering of information systems

III. Qualifying Process:

The student will do two quarter-length tutorials with IST faculty. At the end of these tutorials, the student must make a 45-minute presentation of one of their tutorials to a committee of three IST faculty members. The student can do both tutorials with the same faculty member, in which case the presentation can be of the two tutorials together, and another committee member must be kept informed of the student's progress on a regular basis during the two quarters. The presentation should take place in the spring quarter of the student's second year, or earlier. The presentation must include original research or promising directions towards original research. During this presentation, the student must also provide the name of their chosen focus area, and the list of courses that the student has completed and intends to complete in the core as well as in the chosen focus area. The committee will then make a recommendation to the IST area and the MS&E department regarding qualification of the student for the PhD program in IST.

Economics and Finance

The economics and finance area emphasizes the use of economic and financial concepts, methods, and practice for problem solving, in areas including individual choice, financial engineering, economic policy analysis, and financial market analysis. A strong mathematical and systems analysis background is essential to the area. Students in this area are expected to develop a strong background in economics and finance and closely related disciplines and to obtain experience in addressing significant problem areas.

In addition to beginning an appropriate course program, students must pass two-quarters of tutorial and an oral examination to obtain qualification. The tutorials emphasize basic research skills. The oral examination emphasizes command of basic concepts as represented in the required courses as well as the modeling of practical situations. Students should plan to complete most if not all required courses by the end of the first year of graduate study. The choice courses should be chosen to form a coherent program either in economics, finance or both. PhD students must also meet the department's requirements for both an MS degree and a PhD degree.

Required Courses:

MS&E 201
MS&E 220
MS&E 241, and MS&E 341
MS&E 242, and MS&E 342
MS&E 311
MATH 115 or 171

Choice Courses (select any five, but only one of any grouped alternatives; e.g. MS&E 313 or 314):

<i>General</i>	<i>Economics</i>	<i>Finance</i>
STATS 310A, or MATH 205A	MS&E 344	MS&E 345
EE 263	ECON 270-276	MS&E 347
EE 363	ECON 280-290 (2x)	MS&E 348
MS&E 313, or MS&E 314		MS&E 349
		MATH 136
		GSB 622

Elective Courses:

Students should consult with their dissertation advisors to select additional courses to complete a PhD in their area. These may be in any Stanford department.

Decision Analysis and Risk Analysis

a. Pre-Required

Contents of

CS 106

Engr 60

Math 51

Programming

Engineering Economy

Linear Algebra and Differential Calc of Several Variables

b. Required

MS&E 201

MS&E 211 or MS&E 311

MS&E 220

MS&E 221 or Stat 217

MS&E 223 or MS&E 323

MS&E 241 or MS&E 341

MS&E 250A

MS&E 250B

or MS&E 255B

MS&E 251 or MS&E 351

MS&E 252

MS&E 350 or MS&E 353

MS&E 352

MS&E 355

Stat 200 or 201

or Stat 202 or Econ 271

Dynamic Systems

Linear and Nonlinear Optimization or Optimization

Probabilistic Analysis

Stochastic Modeling or Intro to Stochastic Processes

Simulation or Stochastic Simulation

Economic Analysis or Advanced Economic Analysis

Engineering Risk Analysis

Project Course in Engineering Risk Analysis

Decision Systems II

Stoch Decn Models or Dynamic Progr and Stoch Control

Decision Analysis I: Frontiers of Decision Analysis

Doctoral Seminar in Risk Analysis or Decision Analysis III

Decision Analysis II: Professional Decision Analysis

Influence Diagrams & Probabilistic Networks

Intro to Stat Inference or Design & Analysis of Expmnts

Data Analysis or Intermediate Econometrics II

c. Recommended

Any of the above plus:

MS&E 207

MS&E 242

MS&E 254

MS&E 270

MS&E 280

MS&E 299

MS&E 321 or Stat 218

MS&E 455

CS 228

CS 271

Econ 286

Econ 290

MGTECON 332

Interactive Management Science (spreadsheet course)

Investment Science

Ethical Analyst

Strategy in Technology-Based Companies

Organizational Behavior: Evidence in Action

Designing a Free Society

Stochastic Systems or Introduction to Stochastic Processes

Decision Making in Organizations

Probabilistic Models in Artificial Intelligence

Decision -Making for biomedicine

Game Theory and Economic Application

Multi Person Decision Theory

Analysis of Costs, Risks, and Benefits of Health Care

Production and Operations Management

a. Foundation Courses (required depth courses that can be waived with prior credits, e.g., MS degree in OR or IE at another institution).

MS&E 211 - Linear and Nonlinear Optimization

MS&E 241 or ECON 202N - Economic Analysis

MS&E 260 or MS&E 261 - Analysis of Production and Operating Systems or Inventory Control and Production Systems

b. Methodology Requirements (courses that are normally not waived unless under very special circumstances):

MS&E 221 or Stat 217 - Stochastic Modeling

MS&E 223 or MS&E 323 or STAT 362 – Simulation

MS&E 246 or ECON 203N – Introduction to Game Theory

MS&E 311 or EE 364A - Optimization

MS&E 321 - Stochastic Systems

MS&E 335 - Queuing Systems

MS&E 251 or MS&E 351 or GSB Equivalent – Dynamic Programming

c. POM Research Courses (any four of the following set):

MS&E 361 - Supply-Chain Optimization

MS&E 362 - Advanced Models in Production and Operations

MS&E 363 – Advanced Models in Operations Management

MS&E 364 - Multi-echelon Inventory Models

MS&E 365 - Game Theoretic Models in Operations Management

Faculty-approved GSB OIT Ph.D. Course

Organization, Technology and Entrepreneurship

In their first two years in the Ph.D. program, all students are expected to work with faculty on research. To ensure an early start, all students must work at least 25% of their time in their first year as a research assistant with a faculty member. Students on fellowships can earn course credit for the work. With approval from the students' advisor, one quarter of the requirement may be fulfilled by working as a Course Assistant (CA).

Course requirements for all students of the area.

a. Foundation in Organizational Behavior:

MS&E 38x/37x (x3) - Doctoral Seminars in Organizations and Strategy (three required)
Psych 212 - Social Psychology
Soc 363A - Seminar in Organizational Theory

b. Statistics and Research Methods:

PH.D. students in organizational behavior must take 3 courses in statistics and research methods. Two of these courses must be statistics courses. Courses which can satisfy this requirement include, but are not limited to:

Psych 252 - Statistical Methods for Behavioral and Social Sciences
GSB G640 - Multivariate Data Analysis
Soc 382 - Sociological Methodology II: The General Linear Model
Soc 383 - Sociological Methodology III: Advanced Models for Discrete Outcomes
Soc 384 - New Models and Methods in the Social Sciences

c. Disciplinary Depth:

Ph.D. students are required to take a minimum of 2 advanced-content courses chosen with input from their advisor.

d. Yearly Plan:

Students are expected to complete a yearly plan, of no more than two typed pages in length, detailing the student's plans for the next year in terms of education (e.g., courses and seminars), research (e.g., RAships), and teaching (e.g., TAships). This plan should be provided to the students' academic advisor for review no later than May 15 each calendar year.

Policy and Strategy

Description: The Policy and Strategy (P&S) Area addresses policy and strategy questions in a variety of organizational and societal settings. In order to approach interdisciplinary research questions in application domains as diverse as energy, environment, health, information technology, innovation, and government regulation, P&S faculty members rely on a broad range of analytical and empirical tools, such as decision analysis, optimization and operations research methods, formal economic modeling, econometrics, case studies, and simulation. After having been exposed to foundational knowledge of economics, strategy, and organizational theory, doctoral students in the P&S Area can select from a variety of courses to deepen their understanding of the specific application domains. The P&S Area's mission is to provide a first-class learning and research environment preparing doctoral students for careers at research universities, government institutions, and in the private sector.

Course Requirements: PhD students wishing to concentrate in the Policy and Strategy area must take a total of at least 12 courses. The course requirements are as follows:

a. Foundation in Policy and Strategy:

MS&E 241 – Economic Analysis

MS&E 341 – Advanced Economic Analysis

MS&E 375 or 376 –Doctoral Research Seminar

b. Three additional courses including Statistics and Research Methods. Examples include:

MS&E 201 – Dynamic Systems

MS&E 211 – Linear and Nonlinear Optimization

MS&E 212 – Mathematical Programming and Combinatorial Optimization

MS&E 221 – Stochastic Modeling

MS&E 223 – Simulation

MS&E 352 – Decision Analysis II: Professional Decision Analysis

GSB G640 – Multivariate Data Methods

Soc 383 – Sociological Methodology III

Soc 384 – New Models and Methods in the Social Sciences

Psych 252 – Statistical Methods for the Behavioral and Social Sciences

c. The student must select a program of four or more electives including disciplinary depth courses that reflects his or her interests and that is approved by the P&S faculty.

Following are a number of sample programs:

Sample Program: Modeling Emphasis

Research Methods

MS&E 201 - Dynamic Systems

MS&E 252 - Decision Analysis I: Foundations of Decision Analysis

MS&E 311 - Optimization

MS&E 321 - Stochastic Systems

Domain Depth

MS&E 290 - Public Policy Analysis

MS&E 292 - Health Policy Modeling

MS&E 473 - Project Course in Strategy Modeling

Two of the following:

HRP 205 - Introduction to Health Care Systems and Policy

Econ 256 - Economics of Health and Medical Care

MS&E 292 – Health Policy Modeling

MS&E 243 - Energy and Environmental Policy Analysis

Sample Program: Economics Emphasis

Research Methods

Econ 282 - Contracts, Information, and Incentives

Econ 286 - Game Theory and Economic Applications

MS&E 313 - Vector Space Optimization

MS&E 344 - Applied Information Economics

Domain Depth

Econ 257 - Economics of Industry, Regulation, and Firm Organizations

Econ 285 - Market Design

FNCE 623 - Market Microstructure

MS&E 363 - Advanced Models in Management Science

Sample Program: Strategy Emphasis

Research Methods

GSB 640 – Multivariate Data Methods

MS&E 408 – Directed Reading (Methods Apprenticeship)

Soc 369 - Network Analysis of Formal and Informal Organizations

Soc 386 – Seminar: Event History Analysis

Domain Depth

Econ 224 - Science and Technology in Economic Growth

MS&E 371 - Innovation and Strategic Change

MS&E 376 - Strategy Doctoral Research Seminar: Issues

Soc 314 - Economic Sociology

Sample Program: Strategy Emphasis

Research Methods

GSB 640 – Multivariate Data Methods

MS&E 408 – Directed Reading (Methods Apprenticeship)

Soc 369 - Network Analysis of Formal and Informal Organizations

Soc 386 – Seminar: Event History Analysis

Domain Depth

Econ 224 - Science and Technology in Economic Growth

MS&E 371 - Innovation and Strategic Change

MS&E 376 - Strategy Doctoral Research Seminar: Issues

Soc 314 - Economic Sociology

Sample Program: Risk Analysis Emphasis

Research Methods

MS&E 250a – Engineering Risk Analysis

MS&E 251 – Stochastic Decision Models

MS&E 252 – Decision Analysis I

MS&E 355 – Influence Diagrams and Probabilistic Networks

Domain Depth

MS&E 350 – Doctoral seminar in Risk Analysis

MS&E 250b/452 – Project class in Risk Analysis or Decision Analysis

MS&E 353 – Decision Analysis III

d. Yearly Plan:

Students are expected to complete a yearly plan, of no more than two typed pages in length, detailing the student's plans for the next year in terms of education (e.g., courses and seminars), research (e.g., RAships), and teaching (e.g., TAships). This plan should be provided to the students' academic advisor for review no later than May 15 each calendar year.

Qualifying Procedure

Advancement to PhD candidacy will be determined at the end of the student's second year of studies. It will be based on the following three components:

- the student's overall grade point average in the program (a GPA of 3.5 or higher is required);
- a second-year research paper that is written by the student under the supervision of a faculty member, and that is presented to examining faculty members in the second year;
- a written and an oral qualifying examination taken by the student in the spring quarter of the second year.

Systems Program

Systems concepts and principles are key in research and practice across several domains of modern management science and engineering, ranging from operations and services, to decisions and organizations, and to strategy, policy and government. The new Systems Program of the MS&E Department emphasizes interdisciplinary understanding of systems concepts and applications across various management science and engineering disciplines, and takes the ubiquitous systems perspective in developing unifying principles and advancing novel methods of high impact. Connecting the foundational systems approach to practical modern issues and interesting applied problems, the Systems Program prepares students for leadership positions in academia, industry, business, and government.

In addition to general departmental and University requirements, the student must successfully: (1) pass the program qualifying procedure; (2) select a dissertation advisor; (3) master a set of courses assuring intellectual breadth in analytical concepts; (4) master a set of courses, approved by her or his faculty advisors, assuring depth in some definable area; (5) complete a dissertation, based on original research, which must be a contribution to knowledge; and (6) pass an oral defense of his/her dissertation. In addition, students are strongly encouraged to include a project course and possibly additional non-academic professional experiences, such as an internship. The first four requirements will be discussed more fully in the next paragraphs.

- (1) Pass the Program Qualifying Procedure.** The qualifying procedure will be the departmental research/tutorial requirement, plus an oral exam. The research/tutorial requirement shall be completed in the winter quarter of a student's second year in the Ph.D. program. Faculty associated with this program will determine the nature and format of such an oral exam. The oral exam will take place in the spring quarter (of the second year). All oral exams will be scheduled in a two-week time window.

- (2) Find a Dissertation Advisor.** After qualification, a student in this program has one academic year to secure the signature of a major dissertation advisor, so that he/she will be closely monitored for progress. A Ph.D. candidate in the Systems Program will be able to choose a dissertation advisor from a set of faculty members who have chosen to participate in this program. The student and the dissertation advisor together will determine additional course requirements relevant to the student's research direction.

(3) Master a Set of Courses Assuring Intellectual Breadth in Analytical Concepts. Ph.D. programs must include:

In each of the following areas, at least two courses, one of which has to be in the 300 level.

- Optimization
- Probability
- Dynamic Systems
- Economics/Investment
- Decision Analysis

At least one course in either:

- Organizations (with input from Organizations faculty), or
- One computer conceptual area, to be determined. This will be decided in consultation with the new IST area.

Because most 300-level courses have prerequisite 200-level courses, most Ph.D. candidates will first take these prerequisites. However, students who are adequately prepared may start with 300-level courses. These courses all must be taken for letter grades. A minimum GPA of 3.5 must be achieved in this set of courses.

(4) Master a Set of Courses, Approved by His or Her Faculty Advisors, Assuring Depth in Some Definable Area. Each Ph.D. candidate must acquire additional depth in some field of specialization consistent with the departmental strengths. The student will be responsible for working with his or her advisors to define the area of specialization and to determine the appropriate set of courses to assure appropriate depth. That specialization is likely, but is not required, to be within one of the eight areas in the department.

Operational Issues

In addition to its emphasis on broad mastery of systems concepts, the Systems Program's Ph.D. qualification track allows a student to commit to a dissertation area *later* in her/his Ph.D. program at MS&E – not having to define the area of particular depth before starting the second year. Ph.D. students in this program will acquire a skill set that allows them to commence their dissertation research in several departmental areas. This skill set will also allow them to change their career paths in the future. The resultant requirement will first satisfy the MS&E departmental qualification guidelines/constraints. One can view this “track” as a “boundary free” qualification procedure.

Participating faculty:

Faculty participation in this program means that (1) they will engage in shaping/approving the course work requirement and the nature and format of the oral exam; (2) they will accept the qualifications procedure as valid for their research interests (while there is no obligation to accept any particular thesis student).