

Management Ph.D. Program Requirements

Academic and professional development at the doctoral level is distinct from undergraduate and MBA education. While course work is an important component of your learning process, much of your learning takes place outside classroom time during your own study and interaction with other students and faculty. Ultimately a successful graduate student must make the transition from acquiring knowledge to creating knowledge. That is, to become a scholar in their chose field of study. During this learning process, consider the faculty not only as mentors but also as colleagues. They are very interested in fostering an environment where you can receive the best education available.

The general requirements for the Management Ph.D. program listed below should be viewed as minimum requirements. Your Area Academic Advisor and Area faculty will provide you with additional guidance and requirements during your time as a Ph.D. student to assure you are successful in your career. To assure an up-to-date Ph.D. program, the faculty in each Area regularly reviews and modifies as needed the Area-specific requirements for its doctoral students. The Doctoral Office maintains a comprehensive listing of the current requirements for each Area.

I. General Managerial Skill Requirement

The purpose of the Managerial Skills coursework is to expose students to various functional areas of Management. This coursework provides an exposure to the functional areas of Business, to the case method of teaching, and to professional masters' education. To satisfy the requirements in the general managerial skills (Core) area, a student must take (or receive a waiver based on equivalent master's-level courses) any four of the following six Core courses:

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| MGMT 600 | Financial Accounting |
| MGMT 610 | Financial Management I |
| MGMT 620 | Marketing Management |
| MGMT 650 | Strategic Management |
| MGMT 660 | Operations Management |
| OBHR 681 | Behavior in Organizations |

II. Research-Methods Requirement

The purpose of the research-methods requirement is to prepare students to do research in any Management area. Substantial emphasis is placed on this coursework. Competence in research methods is seen as a defining characteristic of the program. The research-methods requirement is described below. These are minimum requirements and may be increased by the faculty in the student's Major Area.

1. Students must demonstrate competence in research writing. The exact requirements to do so are set by the student's Area Academic Advisor based on an assessment of the student's deficiencies. To assess writing ability, many areas institute a research paper requirement to be completed during the summer following a student's first or second year in residence. This paper applies the material learned in research-methods courses to a specific research question in the student's major area. Often the paper is a collaborative effort with a faculty member. A student who has been identified as requiring training in writing may be asked to participate in tutorials and labs sponsored by the English Department. For instance, there are seminars provided by English Writing Lab instructors ("traveling tutorials") on such topics as: Documenting Sources, Higher Order Concerns (HOCs)/Lower Order Concerns (LOCs), OWL (Online Writing Lab), Peer Response/Editing, Punctuation, Research Papers, Sentence Combining and Clarity, and Transitions.

2. Students must complete a minimum of 2 research-methods topics and a minimum of 5 research-methods courses (15 credit hours). In addition, all students are required to take at least 2 of the 3 courses required for the Applied Statistics Topic. Note that students who take all 3 courses in the Applied Statistics Topic can count this as fulfilling one of their research-methods topic requirements. The research-methods topics and specific courses contained within each topic must be approved by the Area Academic Advisor. As noted above, faculty in an Area may require its students to take more than 2 research-methods topics and/or more than 5 research-methods courses. There are 8 possible research-methods topics

Applied Statistics

Advanced Statistics/Econometrics

Designing Laboratory and Survey Research

Economics

Stochastic Processes

Optimization

Mathematics

Special Topic

There is a minimum school wide grade-point average requirement of 3.2 for courses taken at Purdue University to fulfill the research-methods requirement. Individual Areas may have higher grade-point requirements. In addition, an Area may require its students to pass a preliminary exam covering the research-methods topics. The research-methods requirement must be satisfied before a student takes the preliminary examination in his or her Major area of study.

In attempting to attain this minimum grade-point average, a student may retake any two courses once. If the grade achieved by retaking the course is higher than the initial grade, the second grade will be substituted for the first in computing the student's grade point average for the purpose of satisfying the research-methods grade requirement. If a student does not achieve the minimum 3.2 grade-point average, the student will be dropped from the program.

A waiver or substitution of a course or courses within a specific research method topic is possible with the approval of the Area Academic Advisor and the Director of Doctoral Programs. The research-methods requirement must be fulfilled with courses distinct from courses required to fulfill the Major Area and Minor Area requirements. Below are additional details concerning the course requirements associated with each of the above research topics.

Research-Methods Topics:

Applied Statistics

To complete this research-methods topic, a student is required to take 3 courses, one from each of the following three categories, in the order listed:

Category 1

- ECON 670 Probability Theory and Mathematical Statistics
- STAT 511 Statistical Methods
- STAT 517 Statistical Inference
- STAT 528 Introduction to Mathematical Statistics (STAT 519 is a prerequisite)

Category 2

- ECON 671 Econometrics
- MGMT 672 Quantitative Methods III
- STAT 512 Applied Regression Analysis
- STAT 525 Intermediate Statistical Methodology

Category 3

- ECON 672 Topics in Econometrics
- MGMT 677 Research Methods: Applied Multivariate Analysis
- STAT 524 Applied Multivariate Analysis

Advanced Statistics/Econometrics

To complete this research-methods topic, a student is required to take either 2 or 3 courses of the following 11 courses. The total required number of courses (2 or 3) is determined by the student's Major Area. This research-methods topic has as a pre-requisite the **Applied Statistics** research-methods topic.

- ECON 672 Topics in Econometrics (Unless used to fulfill the Applied Statistics research-methods topic)
- ECON 673 Time Series Methods
- ECON 674 Cross-sectional Econometrics
- MGMT 677 Research Methods: Applied Multivariate Analysis (Unless used to fulfill the Applied Statistics research-methods topic)
- MGMT 679 Nonparametric Methods for Research
- STAT 514 Design of Experiments
- STAT 520 Time Series and Applications
- STAT 524 Applied Multivariate Analysis (Unless used to fulfill the Applied Statistics research-methods topic)
- STAT 526 Advanced Statistical Methodology
- STAT 529 Bayesian Statistics and Applied Decision Theory
- STAT 657 Mathematical Statistics I

Designing Laboratory and Survey Research

To complete this research-methods topic, a student is required to take the following 2 courses.

- OBHR 605 Research Methods in OBHR
- PSYCH 681 Seminar in Research Methodologies of Industrial/Organizational Psychology

Economics

To complete this research-methods topic, a student is required to take ECON 607 and either 1 or 2 additional doctoral-level Economics courses other than those listed under the Applied Statistics and the Advanced Statistics/Econometrics research-methods topics. The required number of courses beyond ECON 607 (1 or 2) is determined by the student's Major Area. Individuals without a strong mathematical background who take this research-methods topic are advised to also take ECON 615.

- ECON 607 Price Theory
- ECON 6** ECON PhD Course Elective(s) (1 or 2 courses)

Stochastic Processes

To complete this research-methods topic, a student is required to take both of the following IE courses or both of the following MATH courses. Note that the IE courses have IE 536 (Stochastic Models in Operations Research I) or equivalent as a prerequisite. Note that the MATH courses have MATH 538/STAT 538 (Probability Theory I) and MATH 539/STAT 539 (Probability Theory II) or equivalent as prerequisites.

- IE 539 Stochastic Service Systems
- IE 636 Stochastic Models in Operations Research II
- or
- MATH 638 Stochastic Processes I (STAT 638 is the same course)
- MATH 639 Stochastic Processes II (STAT 639 is the same course)

Optimization

To complete this research-methods topic, a student is required to take at least 3 of the following 4 courses. Note that IE 535 (Linear Programming) or equivalent is a prerequisite for all of these courses. In addition, IE 536 (Stochastic Models in Operations Research) or equivalent is a prerequisite for IE 633 and IE 537 (Discrete Optimization Models and Applications) or equivalent is a prerequisite for IE 634.

| | |
|--------|---|
| IE 633 | Dynamic Programming |
| IE 634 | Integer Programming |
| IE 635 | Theoretical Foundations of Optimization |
| IE 639 | Combinatorial Optimization |

Mathematics

To complete this research-methods topic, a student is required to take 2 of the following 4 courses. Note that MATH 519/STAT 519 (Intro to Probability) is a prerequisite for MATH 532

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|----------|--|
| MATH 504 | Real Analysis |
| MATH 511 | Linear Algebra With Applications |
| MATH 532 | Elements of Stochastic Processes (STAT 532 is the same course) |
| MATH 544 | Real Analysis and Measure Theory |

Special Topic

To complete this research-methods topic, a student is required to take a 2 or 3 course research-methods special topic sequence that has been formally approved by the Area Academic Advisor. This option can be used to take advantage of new course offerings within and outside of Krannert or to pursue a special research-methods interest of the student.

III. Concentration (Major) Area Requirement

The purpose of the Major Area requirement is to ensure that students are sufficiently knowledgeable in a body of knowledge to be able to competently teach graduate level courses in their chosen subject matter and have a sound basis for future research. To satisfy the Major Area requirement, a student must complete a minimum of 12 credit hours of doctoral-level courses in one of the following Major Areas of study: accounting, finance, management information systems, management science (applied optimization or applied statistics), marketing, operations management, quantitative methods, strategic management, or organizational behavior and human resource management. No course waivers will be considered and no course taken to fulfill the Research-methods Requirement or the Minor Area requirement can be counted in fulfilling the Major Area requirement.

Students should work closely with their Area Academic Advisor in selecting the courses for their Major area. The courses that meet the Major Area requirement must be approved by the Area Academic Advisor in the student's Major Area.

IV. Related (Minor) Area Requirement

The purpose of the Minor Area requirement is to build on the major Area coursework and to broaden the student's knowledge base. To satisfy the Minor Area requirement, a student must complete a minimum of 6 credit hours of doctoral-level courses in related fields, chosen from accounting, finance, management information systems, management science (applied optimization or applied statistics), marketing, operations management, quantitative methods, strategic management, organizational behavior and human resource management, or an area of economics. A Minor outside the Management School must be approved by the Area Academic Advisor in the student's Major Area. No course waivers will be considered and no course taken to fulfill the Research-methods Requirement or the Major Area requirement can be counted in fulfilling the Minor Area requirement.

Students should consult with the Area Academic Advisor who represents their chosen Minor Area as they select the courses for their Minor. The courses that meet the Minor Area requirement must be approved by the Area Academic Advisor in the student's Major Area.

Students will not be required to take a preliminary examination in their Minor. Rather, a student will satisfy the Minor requirement by earning a grade of no less than "B" in each of his or her Minor Area courses. A student must satisfy his or her Minor Area requirement before taking the preliminary examination in his or her Major Area of study.

V. Plan of Study Requirement

Students are required to submit a formal plan of study (POS) to the Purdue Graduate School by the end of the Spring Semester of their second year in the doctoral program, and prior to taking the preliminary examination. If a student enters the program without equivalent course work at the MBA level and must take Core courses, this requirement may be delayed until the start of the student's third year of enrollment.

To submit a plan of study (POS), a student must a) form a POS committee composed of the student's major professor and a minimum of two other qualified faculty members who will supervise the student's dissertation research, b) complete a POS that includes a list of required courses for the Ph.D. degree with the help from his/her Major Professor and the other POS committee members (forms can be obtained from the Ph.D. advising office), c) have the POS approved by the POS committee, and d) file the POS with the Ph.D. advising office. If there are changes in the list of courses or committee membership after the plan is approved in the Graduate School, the student must submit for approval any revisions.

VI. Preliminary Exam Requirement

Students are required to pass a preliminary examination in their Major Area. The exam tests the student's mastery of the broad literature in his or her Major field and knowledge of past and current research activities. Before a student can take this examination, he or she must have completed the course requirements for the Research-methods Requirements and the approved courses in the student's Major and Minor Areas.

A preliminary examination session generally will be held each May and each January. Each Area determines the content and extent of its preliminary examination. A student may be given an oral examination at the discretion of the preliminary examining committee. If a student fails the preliminary examination, the student must retake it the next examination session. If the student fails the exam a second time, the student will be dropped from the program.

VII. Doctoral Dissertation Proposal/Dissertation Committee Requirement

Within 12 months after passing the preliminary examination, a student must formally present, and defend, a dissertation research proposal to his or her formal dissertation committee. As the Graduate School requires at least four members to serve on the examining committee for a Doctoral Final Examination, Management requires at least four members to serve on the Dissertation Proposal Committee. The chairperson, or at least one of the co-chairs, must be from the student's Major Area. At least 3 members must be from the Krannert graduate faculty. It is the student's right to choose and alter the composition of the dissertation committee. However, it is the right of the faculty to decline any student's invitation to serve as a dissertation committee member or chair.

The doctoral dissertation proposal presentation is open to other faculty and to Ph.D. students. To be accepted, a student's research proposal is expected to represent substantial progress toward completion of a doctoral thesis along with a statement of further work to be performed. Once a student's research proposal is accepted by his or her advisory committee, it is to be considered a "contract" which will guide the student through the final preparation of his or her dissertation. If the research proposal is not accepted by the dissertation committee, the student may be given the opportunity to make a second attempt. However, significant delay in achieving an acceptable proposal may be cause for withdrawal from the program.

VIII. Defense of the Dissertation Requirement

For the dissertation, students are expected to demonstrate competence and ability to conduct research as an independent scholar. Also, the dissertation is expected to be a research effort that makes a contribution to the body of knowledge it addresses. During the conduct of the dissertation, students are encouraged to consult their doctoral dissertation committee frequently. It is the student's responsibility to keep the committee informed at all stages.

A student's public defense of his or her dissertation is required. Note that any major concerns committee members may have about the dissertation are expected to be resolved before the public defense of the dissertation is scheduled. The following procedures hold for the dissertation defense and need to be followed:

1. The dissertation must be approved by the dissertation chairperson before it is submitted to the final examining committee. Each member of the dissertation committee shall receive a copy of the dissertation at least two (2) weeks before the date of the final examination.
2. Written notice of the dissertation defense shall be given to Krannert faculty and students at least two (2) weeks prior to the defense.
3. Copies of the dissertation abstract shall be circulated along with a written defense announcement.
4. At least one (1) copy of the full dissertation shall be available, perhaps at the Krannert library reservation desk, for perusal by faculty and students.
5. The defense will be conducted by the dissertation committee under the guidance of the dissertation chairperson. The defense format should allow for adequate presentation of the research work and sufficient time for questions and answers by the committee and others present. The format should also include a time when the public is excused so that the dissertation committee may ask further questions of the candidate or deliberate among themselves.
6. In keeping with Graduate School regulations, only the dissertation advisory committee has the authority to vote for or against the acceptance of the dissertation. These regulations also state the decision rule to be used in determining the final outcome of the defense. Currently, for example, there may be a maximum of one dissenting vote in a successful defense of a dissertation.

Students are cautioned to familiarize themselves with the full set of school and university regulations regarding dissertation format and procedures. It is the student's responsibility to ensure that they comply with these regulations.

Research-Methods Topics With Course Content Descriptions

Applied Statistics

To complete this research-methods topic, a student is required to take 3 courses, one from each of the following three categories, in the order listed:

Category 1

- ECON 670 Probability Theory and Mathematical Statistics
Includes estimation and hypothesis testing
- STAT 511 Statistical Methods
An introduction to probability and statistical methods for students with one year of calculus.
- STAT 517 Statistical Inference
A basic course in statistical theory covering standard statistical methods and their application. Estimation including unbiased, maximum likelihood and moment estimation; testing hypotheses for standard distributions and contingency tables; confidence intervals and regions; introduction to nonparametric tests and linear regression.
- STAT 528 Introduction to Mathematical Statistics (STAT 519 is a prerequisite)
Distribution of mean and s^2 in normal samples, sampling distributions derived from the normal distribution Chi square, t and F. Distribution of statistics based on ordered samples. Asymptotic sampling distributions. Introduction to multivariate normal distribution and linear models. Sufficient statistics, maximum likelihood, least squares, linear estimation, other methods of point estimation, and discussion of their properties, Cramer-Rao inequality and Rao-Blackwell theorem. Tests of statistical hypotheses, simple and composite hypotheses, likelihood ratio tests, power of tests.

Category 2

- ECON 671 Econometrics
Classical Regression Model, focusing on adjustments for failures of the standard stochastic assumptions of the analysis. Requires students to use instructor-specified statistical package(s).
- MGMT 672 Quantitative Methods III
Application of estimation, hypothesis testing, multiple regression and related techniques to the analysis of research problems found in managerial studies. Requires students to use instructor-specified statistical package(s).
- STAT 512 Applied Regression Analysis
Inference in simple and multiple linear regression, residual analysis, transformations, polynomial regression, model building with real data, nonlinear regression. One-way and two-way analysis of variance, multiple comparisons, fixed and random factors, analysis of covariance. Use of existing statistical computer programs.
- STAT 525 Intermediate Statistical Methodology
Likelihood methods for analyzing data based on generalized linear models, and diagnostic methods for assessing the assumptions of such models. Introduction to statistical computer packages. methods covered include multiple regression, analysis of variance for completely randomized designs, logistic response models, and hierarchical log linear models for contingency tables.

Category 3

- ECON 672 Topics in Econometrics
Topics to include panel data techniques, unobservable, qualitative, and limited dependent variable models, basic time series analysis, and nonlinear statistical models. Requires students to use instructor-specified statistical package(s). (Requires ECON 671)
- MGMT 677 Research Methods: Applied Multivariate Analysis
Applied multivariate statistical methods such as discriminant analysis and multivariate analysis of variance for research problems found in managerial studies. Requires students to use instructor-specified statistical package(s).
- STAT 524 Applied Multivariate Analysis
Extension of univariate tests in normal populations to the multivariate case, equality of covariance matrices, multivariate analysis of variance, discriminant analysis and misclassification errors, canonical correlation, principal components, factor analysis. Strong emphasis will be placed on use of existing computer programs.

Advanced Statistics/Econometrics

To complete this research-methods topic, a student is required to take either 2 or 3 of the following 9 courses. The total number of courses (2 or 3) is determined by the student's Major Area. This research-methods topic has as a pre-requisite the **Applied Statistics** research-methods topic.

- ECON 672 **Topics in Econometrics** (Unless used to fulfill the Applied Statistics research-methods topic)
Topics to include panel data techniques, unobservable, qualitative, and limited dependent variable models, basic time series analysis, and nonlinear statistical models. Requires students to use instructor-specified statistical package(s).
- ECON 673 **Time Series Methods**
This course has as a pre-requisite ECON 672
- ECON 674 **Cross-sectional Econometrics**
This course has as a pre-requisite ECON 672
- MGMT 677 **Research Methods: Applied Multivariate Analysis** (Unless used to fulfill the Applied Statistics research-methods topic) Applied multivariate statistical methods such as discriminant analysis and multivariate analysis of variance for research problems found in managerial studies. Requires students to use instructor-specified statistical package(s).
- MGMT 679 **Nonparametric Methods for Research**
Distribution-free statistical methods for managerial research. Analysis of location and scale measures, nonparametric comparison procedures, association and contingency table analysis, nonparametric goodness-of-fit procedures, and tests for randomness, nonparametric regression and other measures of association, computer intensive statistical methods
- STAT 514 **Design of Experiments**
Fundamentals, completely randomized design; randomized complete blocks; latin square; multiclassification; factorial; nested factorial; incomplete block and fractional replications for $2n$; $3n$; $2m 3n$, confounding; 12 lattice designs; general mixed factorials; split plot; analysis of variance in regression models; optimum design. Use of existing statistical programs.
- STAT 520 **Time Series and Applications**
A first course in stationary time series with applications in engineering, economics, and physical sciences. Stationarity, autocovariance function and spectrum; integral representation of a stationary time series and interpretation; linear filtering, transfer functions; estimation of spectrum; multivariate time series. Use of computer programs for covariance and spectral estimation.
- STAT 524 **Applied Multivariate Analysis** (Unless used to fulfill the Applied Statistics research-methods topic)
Extension of univariate tests in normal populations to the multivariate case, equality of covariance matrices, multivariate analysis of variance, discriminant analysis and misclassification errors, canonical correlation, principal components, factor analysis. Strong emphasis will be placed on use of existing computer programs.
- STAT 526 **Advanced Statistical Methodology**
Computationally intensive methods in statistics including bootstrapping, Monte Carlo simulation, nonparametric density estimation, nonparametric regression and methods appropriate for high-dimensional data. Extensive use is made of statistical software.
- STAT 529 **Bayesian Statistics and Applied Decision Theory**
Bayesian and decision theoretic formulation of problems; construction of utility functions and quantifications of prior information; methods of Bayesian decision and inference, with applications; empirical Bayes; combination of evidence; Bayesian design and sequential analysis; comparisons of statistical paradigms.
- STAT 657 **Mathematical Statistics I**
Sequential analysis. Sequential probability ratio test. Approximations. Open-ended tests. Sequential Bayes rules. Robustness. Complete class theorems. Monotone likelihood ratio families. Essentially complete classes. Most powerful tests in restricted classes. Unbiasedness. Similarity. Invariance. Maximal invariants. Most powerful invariant tests.

Designing Laboratory and Survey Research

To complete this research-methods topic, a student is required to take the following 2 courses.

OBHR 605 Research Methods in OBHR

Introduction to the design and conduct of organizational research including philosophy of science, reliability and validity of data collection methods, experimental and quasi-experimental design, threats to research validity, and the development of survey research approaches.

PSYCH 681 Seminar in Research Methodologies of Industrial/Organizational Psychology

Analysis of application of various research and statistical methods to the study of human behavior in organizations. Topics might include questionnaire construction, introduction to measurement development and validation, observational techniques, sampling, aggregation of data, cross-level effects in research, and contemporary developments in multivariate analysis of data.

Economics

To complete this research-methods topic, a student is required to take ECON 607 and either 1 or 2 additional courses from the list below. The total number of courses beyond ECON 607 to take (1 or 2) is determined by the student's Major Area. Individuals without a strong mathematical background who take this research-methods topic are advised to also take ECON 615.

ECON 607 Price Theory

Development of demand and production theory from both neoclassical and modern view points; an introduction to markets and basic game theory.

ECON 610 Game Theory

An introduction to the theory of games. Topics include game forms, Nash equilibrium, non-Nash solution concepts, repeated games, multistage games with observed actions, Bayesian games and Bayesian equilibrium, equilibrium refinements, and cooperative games.

ECON 6** ECON PhD Course Elective

This course could be Information and Uncertainty (ECON 676), Industrial Organization (ECON 620 or ECON 621), Experimental (ECON 690), Macroeconomic Theory (ECON 608) or another course that is approved by your Area Academic Advisor.

Stochastic Processes

To complete this research-methods topic, a student is required to take both of the following IE courses or both of the following MATH courses. Note that the IE courses have IE 536 (Stochastic Models in Operations Research I) or equivalent as a prerequisite. Note that the MATH courses have MATH 538/STAT 538 (Probability Theory I) and MATH 539/STAT 539 (Probability Theory II) or equivalent as prerequisites.

IE 539 Stochastic Service Systems

Theory and application of models of stochastic service systems. Stationary Markov models, nonstationary Markov models, and general models. Numerical algorithms and approximation methods are emphasized.

IE 636 Stochastic Models in Operations Research II

The continued development of mathematical models of discrete valued stochastic phenomena, with applications to queuing processes, machine repair problems and inventory policy. Poisson processes, renewal processes, semi-Markov and Markov renewal processes. Regenerative processes and renewal reward processes. Multi-dimensional birth and death queuing models.

or

MATH 638 Stochastic Processes I (STAT 638 is the same course)

Advanced topics in probability theory which may include stationary processes, independent increment processes, Gaussian processes; martingales, Markov processes, ergodic theory.

MATH 639 Stochastic Processes II (STAT 639 is the same course)

Continuation of MA 638

Optimization

To complete this research-methods topic, a student is required to take at least 3 of the following 4 courses. Note that IE 535 (Linear Programming) or equivalent is a prerequisite for all of these courses. In addition, IE 536 (Stochastic Models in Operations Research) or equivalent is a prerequisite for IE 633 and IE 537 (Discrete Optimization Models and Applications) or equivalent is a prerequisite for IE 634.

- IE 633 **Dynamic Programming**
Theory and applications of finite and infinite stage sequential decision processes.
- IE 634 **Integer Programming**
An advanced course on theory and algorithms for integer and mixed-integer optimization problems.
- IE 635 **Theoretical Foundations of Optimization**
An advanced course in theoretical foundations of mathematical programming.
- IE 639 **Combinatorial Optimization**
An advanced course in combinatorial optimization.

Mathematics

To complete this research-methods topic, a student is required to take 2 of the following 4 courses. Note that MATH 519/STAT 519 (Intro to Probability) is a prerequisite for MATH 532

- MATH 504 **Real Analysis**
Completeness of the real number system, basic topological properties, compactness, sequences and series, absolute convergence of series, rearrangement of series, properties of continuous functions, the Riemann-Stieltjes integral, sequences and series of functions, uniform convergence, the Stone-Weierstrass Theorem, equicontinuity, the Arzela-Ascoli Theorem.
- MATH 511 **Linear Algebra With Applications**
Real and complex vector spaces; linear transformations; Gram-Schmidt process and projections; unitary and orthogonal diagonalization; Jordan canonical form; quadratic forms.
- MATH 532 **Elements of Stochastic Processes (STAT 532 is the same course)**
A basic course in stochastic models, including discrete and continuous time Markov chains and Brownian motion, as well as an introduction to topics such as Gaussian processes, queues, epidemic models, branching processes, renewal processes, replacement, and reliability problems.
- MATH 544 **Real Analysis and Measure Theory**
Metric space topology; continuity, convergence; equicontinuity; compactness; bounded variation, Helly selection theorem; Riemann-Stieltjes integral; Lebesgue measure; abstract measure spaces; L_p -spaces; Hölder and Minkowski inequalities; Riesz-Fischer theorem.

Special Topic

To complete this research-methods topic, a student is required to take a 2 or 3 course research-methods special topic sequence that has been formally approved by the Area Academic Advisor. This option can be used to take advantage of new course offerings within and outside of Krannert or to pursue a special research-methods interest of the student.