ACC 501. SEMINAR IN ACCOUNTING
(Offered each quarter, 1 credit. First-year PhD students are graded on a P/F basis. Second-year and later students receive a letter grade.)
A forum for the presentation, discussion and critique of current accounting research papers where accounting faculty, PhD students and outside speakers present working papers on current research topics. Students are expected to actively participate in the discussion and critique of the papers presented. In weeks when accounting workshops/seminars are scheduled, accounting PhD students will meet as a group with a member of the accounting faculty before the seminar to discuss the paper. Since such meetings are designed to facilitate students’ active participation in the seminars, students are required to circulate a brief set of comments to the other class participants in advance of the meeting. Grading will be based on the quality of students’ contributions to the pre-seminar meetings as well as their contributions and participation in the actual workshops.

ACC 510. ACCOUNTING RESEARCH I
(Offered Fall Quarter, 3 credits.)
The natural starting point for the study of capital markets research in accounting begins with the relationship between accounting earnings and security returns. This course covers the evolution of research on the earnings-return relation from the seminal papers up through current research. Topics covered include the fundamental properties of the contemporaneous earnings-return relation, the nature of association-type and event-study-type investigations of the contemporaneous earnings-return relation, theoretical and empirical evidence on the lead/lag relation between security returns and accounting earnings, the asymmetric timeliness of accounting earnings, theoretical and empirical research on the role of conservatism in accounting earnings, pro-forma earnings and international research on the characteristics and properties of the earnings-return relation. The course also covers capital market research on analysts’ forecasts including the properties of such forecasts (e.g., optimism, pessimism, rationality) and the relation between analyst earnings forecasts and stock prices.

ACC 511. ACCOUNTING RESEARCH II
(Offered Winter Quarter, 3 credits.)
This course turns the focus from aggregate accounting earnings (which is studied in ACC 510), to the components of earnings; accruals and cash flow. Given the central role of accruals in the measurement of accounting earnings, the initial focus of the course is on the fundamental properties of accruals and the importance of accruals to accounting earnings central role as a summary measure of firm performance. The course also covers the relation between cash flow and accruals and the market pricing of accruals and the components of accruals. The study of accruals naturally leads to research on earnings management that focuses on how and why earnings are managed. Research on how earnings are managed focuses on managers’ opportunistic manipulation of accounting accruals and/or via altering real activities while research on the managerial incentives to manage reported earnings focuses on (among other topics) the literature on meeting or beating earnings expectations and earnings thresholds. The course also covers the topic of voluntary disclosure. In particular, the incentives managers have to voluntarily disclose earnings and/or cash flow forecasts and the properties and stock price effects of such forecasts. Other voluntary disclosure literature studied includes the effect of voluntary disclosure on the cost of capital and the effect of the legal environment on firms’ voluntary disclosure practices.
Prerequisite: ACC 510

ACC 512. ADVANCED TOPICS IN ACCOUNTING RESEARCH
(Offered Spring Quarter and alternates with ACC 513, 3 credits.)
This course covers advanced topics in accounting research including the role of accounting numbers in debt contracts and lending agreements, the role of accounting numbers in executive compensation contracts and corporate governance, the economic consequences of accounting regulation, the use of accounting-based measures of the cost of capital and empirical tax research in accounting.
Prerequisites: ACC 510 and ACC 511

ACC 513: CONTEMPORARY TOPICS IN ACCOUNTING RESEARCH
(Offered Spring Quarter and alternates with ACC 512, 3 credits.)
This course covers topics including value relevance, accounting-based valuation models, earnings quality, the impact of earnings and accrual quality on firm valuation, the impact of real activity management on firm performance, market efficiency with respect to accounting numbers, the economic consequences of fraudulent financial reporting and the effects of accounting restatements.
Prerequisites: ACC 510 and ACC 511

ACC 520: CAUSAL INFERENCE
(cross listed as AEC 520 and MKT 520)
The course will cover how to design compelling research, the focus of which is causal inference. The course covers the design of true experiments and concepts of validity (internal validity, external validity, replicability). The approach should follow the Rubin potential outcomes framework. The course then covers causal inference and related econometric methods in observational studies for cross-sectional, panel data, and time-series, and non-linear models including OLS, instrumental variables, Heckman selection models, regression discontinuity designs, matched sample designs, granger causality, event studies, diff-in-diff, fixed effects, clustering standard errors, dynamic panel methods (e.g., Blundell and Bond 1998), and some issues in logit/probit/multinomial logit. Although the course will discuss many econometric techniques, students are expected to have already learned the mechanics of these methods, so that the course can focus on causal inference and its limitations in these methodologies.

AEC 505. REAL ANALYSIS
The course introduces mathematical tools especially useful in economics, econometrics and finance. Topics include a basic topology of the real line, sequences and series, limits, continuity, differential and integral calculus. Offered in the summer, primarily for entering doctoral students.

AEC 506. PROBABILITY THEORY
This course teaches Random Variable, Distribution, Independence: Transformations and Expectations; Common Families of Distributions; Multiple Random Variables, and Markov Chains. Offered in the summer, primarily for entering doctoral students.

AEC 510. PHD WORKSHOP IN APPLIED ECONOMICS
The workshop provides a forum for the presentation of ongoing and completed research projects by PhD students in the economics core. Third- and fourth-year PhD students are expected to participate actively.
Prerequisite: permission of the instructor

AEC 511. ADVANCED PRICE THEORY
Provides a survey of the substance and methods of contemporary price theory for students preparing to do research. Generally, the course covers the economic behavior of individuals and firms in a competitive market setting.
Individual behaviors examined include responses to price and income changes, intertemporal planning (e.g., saving), household production, labor supply, investment in human capital, search, and reactions to uncertainty about future assets and goods prices. For firms, the implications of value-maximization for input demands and output supplies are explored thoroughly. Managerial choices related to multiple products, intertemporal production planning and uncertainty are explicitly modeled. Some extensions to monopoly behavior are considered. Finally, some implications of consumer and competitive firm behavior for industry (single market) and general equilibrium are examined. These include (for industry equilibrium) the technological determinants of industry responses (entry-exit, quantity changes, price changes) to economic shocks such as shifts in demand for the industry’s product. For general equilibrium, the first and second welfare theorems will be covered. This course will follow the semester schedule.

AEC 512. GAME THEORY
This course teaches the tools of game theory, and applies them to topics in industrial organization, organizational economics and other areas. Game theory is the study of strategic interaction among a small number of decision-makers. It is nowadays applied in almost any area of economics, as well as in related disciplines such as finance, accounting, marketing and operations research. The course is organized by concepts and methods, but most time will be spent on applying them to a large variety of topics. While this is a theory course, the instructor will also occasionally refer to relevant empirical work.

AEC 513. INDUSTRIAL ORGANIZATION THEORY
This course provides an introduction to the theory and practice of industrial organization. Broad areas of application include static oligopoly models, two-stage games and games with infinite horizons. Concepts from game theory such as Nash equilibrium, subgame perfect equilibrium, and perfect Bayesian equilibrium will be used as needed. Special topics may include: contracts, patents, licensing, bundling, tying, buyer-seller networks, switching costs, price discrimination, mergers and entry barriers.

AEC 520. CAUSAL INFERENCE
(cross listed as ACC 520 and MKT 520)
The course will cover how to design compelling research, the focus of which is causal inference. The course covers the design of true experiments and concepts of validity (internal validity, external validity, replicability). The approach should follow the Rubin potential outcomes framework. The course then covers causal inference and related econometric methods in observational studies for cross-sectional, panel data, and time-series, and non-linear models including OLS, instrumental variables. Heckman selection models, regression discontinuity designs, matched sample designs, granger causality, event studies, upper-in-down, fixed effects, clustering standard errors, dynamic panel methods (e.g., Bound and Bond 1998), and some issues in logit/probit/multinomial logit. Although the course will discuss many econometric techniques, students are expected to have already learned the mechanics of these methods, so that the course can focus on causal inference and its limitations in these methodologies.

AEC 523. MICRO-ECONOMETRIC MODELING: STATIC APPROACHES
This course introduces students to canonical modeling approaches for analyzing decision making by both firms and consumers, focusing on static environments. Central topics include demand estimation, models of strategic interaction, networks and platforms and auctions. Applications include firm pricing decisions, new product introductions, strategic entry and vertical relationships. The course generally includes coding assignments and student presentations, in addition to the weekly lectures on methods and applications.

AEC 524. MICRO-ECONOMETRIC MODELING: DYNAMIC APPROACHES
This course examines consumer and firm behaviors that involve inter-temporal trade-offs and as a result involve dynamic optimization on the part of both consumers and firms. It begins with an overview of dynamic programming methods, in both single and multi-agent settings, emphasizing methods that link estimation with computation. Single agent topics include models of capital replacement, dynamic demand, inventory models and salesforce management. Multi-agent topics include strategic innovation, learning by doing, demand smoothing, and product repositioning. A strong emphasis is placed on recent methods and frontier topics. The course generally includes coding assignments and several student presentations, in addition to weekly lectures.

AEC 525. MATHEMATICAL ECONOMICS I
(Same as ECO 481)
(Offered at the discretion of the instructor)
Credit—four hours
This course covers the use of optimization theory in economic analysis. The topics covered include finite-dimensional optimization (unconstrained optimization, Lagrange’s Theorem, the Kuhn-Tucker Theorem), the role of convexity in optimization, parametric continuity of solutions to optimization problems, and finite- and infinite-horizon dynamic programming.

Prerequisite: AEC 505

APPLIED STATISTICS

APS 514. INTRODUCTION TO ECONOMETRICS
(Same as College course ECO 484)
Credit—two hours
The course is for students intending to do research in quantitative areas. Topics include: estimation and hypothesis testing in the standard linear model, weighted least squares, transformations, constraints, analysis of variance and covariance and problems of model specification.
Prerequisites: AEC 505 or equivalent and APS 511 or equivalent

APS 515. ELEMENTS OF ECONOMETRICS
(Same as College course ECO 485)
Credit—four hours
The course starts with the single-equation linear model, focusing on OLS estimation and instrumental variables estimation. Then it moves to a linear system of equations model and covers system OLS estimation, generalized least squares estimation, and generalized method of moments. It ends topics of the linear model with linear unobserved effects panel data models. Then the course moves to nonlinear estimation, covering the M-Estimators and discrete response models. If time permits, a few more advanced topics will also be covered.

The course assumes familiarity with matrix algebra, probability theory, basic statistics, and econometrics at the level of ECO 483 and ECO 484. The course requires programming in Matlab for some problem sets.
Prerequisite: APS 514

APS 519. TOPICS IN MICROECONOMETRICS
The course content varies from year to year. Panel data, cross-section time series, qualitative dependent variables and duration analysis are possible topics discussed.
Prerequisite: ECO 517 or permission of the instructor

APS 523. ADVANCED ECONOMETRICS
(Same as College course ECO 517)
Credit—five hours
The course covers advanced topics in econometrics, including maximum likelihood methods and methods of moment estimation. Also discussed are asymptotic theory, and semiparametric and nonparametric estimation.
Prerequisite: APS 515
APPS 524. TOPICS IN MACROECONOMETRICS
(Same as College course ECO 518)
Credit—five hours
The course focuses on the econometric techniques and problems associated with particular fields in economics, such as the econometrics of labor economics and the econometric issues in macroeconomics or finance.
Prerequisite: APS 523 or permission of the instructor

APPS 528. SAMPLING TECHNIQUES
(Same as Medical School course BST 421; APPS 528 is offered in alternate years)
Credit—four hours
The course is for students with a primary interest in applied statistics or research in quantitative areas. Topics include: design and analysis of simple random, stratified, cluster and systematic sampling; multistage and multilayer sampling; and nonresponse and measurement errors.
Prerequisites: GBA 411, GBA 412 and differential calculus

APPS 529. APPLIED MULTIVARIATE ANALYSIS
(Same as Medical School course BST 441; APPS 529 is offered in alternate years)
Credit—two hours
This course examines the theory and applications of multivariate methods often used in economics, marketing and finance. Topics include: multivariate normal distributions, sampling distributions, tests of hypotheses, multivariate analysis of variance, canonical correlation, principal components and factor analysis.
Prerequisite: APPS 514

APPS 531. APPLIED ECONOMETRICS
The course aims to provide PhD students with a broad set of applied econometric skills. The contents of the course have been designed as to provide the broadest group of students fairly in-depth exposure to key topics in Panel Data methods that would be useful in their research endeavor. These methods have applications in accounting, corporate finance, marketing, and more recently in operations management and information systems.

The course will be broken up into four modules. The first module is a refresher to topics already covered in the introductory sequence of econometrics courses. The focus, however, would be for students to grasp the idea behind the methods in a more applied setting. The second module introduces students to Panel Data and the issues involved with the estimation of models based on such data. The third module forms the core of the course and focuses on simulation-based econometric methods. In this module, the models discuss both reduced form and structural models applied to cross-sectional as well as panel data. The course concludes with a quick introduction to Bayesian ideas and methods.

FIN 511. CONTINUOUS TIME THEORY IN FINANCE
The course builds on the basic theory presented in FIN 505 Theory of Finance. FIN 511 will emphasize some relatively advanced mathematical methods that are used in the research literature of financial economics. The objective of the course is to provide the student with enough knowledge of these methods that he or she can begin to use them in nontrivial ways in his or her research. Particular emphasis is given to topics that are costly or difficult to learn on an individual basis.

The methods surveyed in the course are primarily techniques for constructing and analyzing continuous-time models of trading and of stochastic asset price behavior. Virtually all of the derivative security pricing models and many of the multifactor models of asset prices and the term structure of interest rates are of this type.

FIN 512. EMPIRICAL ASSET PRICING
This course covers classic contributions and recent developments in capital markets research, both applied theoretical and empirical, in relation to corporate policies, business cycle and economic growth. Specific topics include time-series predictability of stock market returns, empirical methods and evidence on the cross-section of returns, evidence on mutual fund performance and the closed-end fund puzzle, event studies and the empirical relations between stock returns and corporate policies, consumption-based asset pricing, applied equilibrium modeling of asset pricing anomalies and behavioral finance.

FIN 513. AGENCY THEORY
The course studies game theoretic foundations of the theory of the firm. The strong emphasis is placed on corporate finance. The topics include capital structure, asymmetric information and signaling, contract design, and optimal security design. In addition, we look into information aggregation in financial markets, bargaining with asymmetric information, and dynamic signaling — important and fascinating topics in the broader area of information economics.

FIN 514. EMPIRICAL CORPORATE
This course covers cross-sectional and panel data empirical methods used in corporate finance research. The course will expose students to a variety of methods commonly employed in empirical research. While the course will cover the efficiency and consistency of various estimators, the primary focus will be on how econometric tools can be used to identify unbiased causal effects. Lectures and econometric readings will provide students
with econometric intuition behind each method covered in the course. Course readings will expose students to examples of the methods being used in published and working papers. Assignments will familiarize students with standard datasets used in corporate finance and will enable students to apply the methods covered in the course and to analyze and critique other researchers’ use of common empirical methods.

FIN 523. ADVANCED AGENCY THEORY
The course studies dynamic aspects of the theory of the firm. The strong emphasis is placed on the role of time and repeated decisions in firm management. The topics include real options, dynamic lemons markets, dynamic contracts, and investment under constraints. The course is research intensive, requiring completion of several referee reports and a term project.

FIN 535. TOPICS IN FINANCE
This course will expose students to advanced topics in finance, including current work in different financial topics. An emphasis will be put on the link between empirical and theoretical work, and how to think about research questions critically.

GENERAL BUSINESS ADMINISTRATION

GBA 591. PHD READING COURSE
GBA 594. PHD INDEPENDENT STUDY
GBA 595. PHD RESEARCH
GBA 995. CONTINUATION OF DOCTORAL ENROLLMENT
GBA 999. WRITING DISSERTATION

MANAGEMENT SCIENCE METHODS

MSM 502. LINEAR ALGEBRA
The goal of this course is to give an introduction to linear algebra. Topics include: Gaussian elimination, matrix operations, matrix inverses. Vector spaces and subspaces, linear independence, and the basis of a space. Row space and column space of a matrix, fundamental theorem of linear algebra, linear transformations. Orthogonal vectors and subspaces, orthogonal bases, and Gram-Schmidt method. Orthogonal projections, linear regression. Determinants: how to calculate them, properties, and applications. Calculating eigenvectors and eigenvalues, basic properties. Matrix diagonalization, application to difference equations and differential equations. Positive definite matrices, tests for positive definiteness, singular value decomposition. Classification of states, transience and recurrence, classes of states. Absorption, expected reward. Stationary and limiting distributions. Offered in the summer, primarily for entering doctoral students.

MSM 503. OPTIMIZATION
This course covers Optimization in \( R^n \), Weierstrass Theorem, Unconstrained optimization, Lagrange Theorem and equality constraints, Kuhn-Tucker Theorem and Inequality constraints, Convexity, Parametric Monotonicity and Supermodularity. Offered in the summer, primarily for entering doctoral students.

MSM 504. THEORY OF PROBABILITY AND STOCHASTIC PROCESSES I
The course provides an introduction to stochastic processes. Topics include the Poisson process, renewal theory, Markov chains, semi-Markov and Markov renewal processes, and regenerative processes.
Prerequisite: Some knowledge of functions of a real variable (MTH 265) and probability (BST 401)

MSM 505. THEORY OF PROBABILITY AND STOCHASTIC PROCESSES II
The course will study advanced topics in stochastic processes, with emphasis on problem modeling and computation. The following topics will be covered: models using discrete time Markov chains, optimal stopping and discrete time Markov chains, models using continuous time Markov chains, Markov decision processes for discrete time Markov chains, and if time permits, diffusion processes/martingales.

MSM 506. MANAGEMENT SCIENCE METHODS
The purpose of this course is to introduce PhD students to a variety of operations research and management science methods in an applied setting to develop their modeling abilities. The emphasis of the course is on defining problems, building models, and analyzing the models to gain some insight, in other words, critical research skills. This course will draw upon both deterministic optimization methods and stochastic models but not their theory. These will include linear programming including integer and network formulations, basic queueing models (M/M/1, M/M/n, M/G/1), and Monte Carlo simulation.

MSM 542. QUEUING THEORY AND APPLICATIONS
The course offers in-depth study of queues and networks of queues, including single- and multiserver-queues; Markovian models of phase-type systems; open-and-closed networks of queues; product-form solutions and local balance; bottleneck-analysis approximations and computational aspects. It also covers applications to scheduling, resource allocation and capacity-expansion decisions in service systems, computer systems and job shops.
Prerequisite: MSM 504 or Medical School course BST 402, or permission of the instructor

MSM 549 MARKOV DECISION PROCESSES
This course is as an introduction to sequential decision-making and it reviews the theoretical foundations of dynamic programming, stochastic control, and Markov decision processes. Much of the course is devoted to the theoretical, modeling, and computational aspects of Markov decision processes. Applications in the area of production and inventory, finance, and marketing are explored.
Prerequisites: MSM 504 and MSM 505 or equivalent.

MARKETING

MKT 501. WORKSHOP IN MARKETING
Non-credit
This workshop provides a forum for the presentation of ongoing and completed research by students, faculty and visiting scholars. PhD students are expected to participate actively.
Prerequisite: permission of the instructor

MKT 511. ADVANCED TOPICS IN MARKETING I
This course is the first leg of a three-part sequence that prepares PhD students for research in marketing. The presentation of topics between the three parts may vary from year to year. The aim is to survey the literature, assess progress and identify opportunities for future research.
Prerequisite: permission of the instructor

MKT 512. ADVANCED TOPICS IN MARKETING II
In this second part of a three-part sequence that prepares PhD students for research in marketing, topics are discussed in a format similar to MKT 51.1.
Prerequisite: permission of the instructor
MKT 513. ADVANCED TOPICS IN MARKETING III

In this third part of a three-part sequence that prepares PhD students for research in marketing, topics are discussed in a format similar to MKT 511 and MKT 512.

Prerequisite: permission of the instructor

MKT 520. CAUSAL INFEERENCE
(cross listed as ACC 520 and MKT 520)

The course will cover how to design compelling research, the focus of which is causal inference. The course covers the design of true experiments and concepts of validity (internal validity, external validity, replicability). The approach should follow the Rubin potential outcomes framework. The course then covers causal inference and related econometric methods in observational studies for cross-sectional, panel data, and time-series, and non-linear models including OLS, instrumental variables, Heckman selection models, regression discontinuity designs, matched sample designs, granger causality, event studies, diff-in-diff, fixed effects, clustering standard errors, dynamic panel methods (e.g., Blundell and Bond 1998), and some issues in logit/probit/multinomial logit. Although the course will discuss many econometric techniques, students are expected to have already learned the mechanics of these methods, so that the course can focus on causal inference and its limitations in these methodologies.

OPERATIONS MANAGEMENT

OMG 501, 502, 503, 521, 522, 523.
PHD SEMINARS IN OPERATIONS MANAGEMENT

These six PhD seminars are offered in the fall, winter and spring quarters, with major topics such as the following: distribution/inventory theory; flexible-manufacturing systems; production batching, scheduling and sequencing; reliability/maintenance management; design strategy; routing/vehicle scheduling; quality; production-control systems; and planning models. Topics for the joint CIS/OMG seminars include: computer-integrated manufacturing, network-based industries, performance evaluation of dynamic systems, business expert systems and artificial intelligence.

OMG 531. ANALYSIS OF PRODUCTION SYSTEMS

The course introduces the theory of production and inventory systems, and discusses mathematical models used in designing and managing real-world systems. Topics include: aggregate production planning, static and dynamic approaches to operations scheduling, inventory control with known and uncertain demand, flexible and high-volume manufacturing systems, hierarchical production planning systems and manufacturing resource planning.