

# ECONOMICS (ECON-GA)

## **ECON-GA 1001 Math for Economists (MA) (3 Credits)**

*Typically offered Fall*

Applications of mathematics to economics: functions, simultaneous equations; linear models and matrix algebra; determinants, inverse matrix, Cramer's rule; differentiation and optimization of functions of one or more variables; quadratic forms, characteristic roots and vectors, constrained optimization; interpretation of the Lagrange multiplier. Techniques applied to examples from the theory of the firm and consumer behavior.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1003 Microeconomics (MA) (3 Credits)**

*Typically offered Spring*

Applied microeconomics relating to the firm in various markets and household behavior.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1005 Macroeconomics(MA) (3 Credits)**

*Typically offered Fall*

Macroeconomic theory applied to aggregate supply and demand and their components, designing and implementing macroeconomic policy goals and forecasting GDP and its components.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1006 Macroeconomic Theory II (3 Credits)**

*Typically offered occasionally*

Macroeconomic theory applied to current controversial topics in the field.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1021 Math F/Economists I-PhD (4 Credits)**

*Typically offered Fall*

Reviews theory of calculus, linear algebra, and constrained optimization. Theory and methods of differential equations, calculus of variations, optimal control theory, and dynamic programming applied to economic problems.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1022 Math for Economists II (PhD) (4 Credits)**

*Typically offered Spring*

Methods and applications of optimal control theory to problems of economics. Discusses economic applications of stochastic processes, probability, measure theory, and topology.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1023 Microeconomics I (PhD) (4 Credits)**

*Typically offered Fall*

Theory of the firm and consumer behavior; introduction to the theory of perfectly competitive and monopolistic markets; pricing techniques; introduction to game theory.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1024 Microeconomics II (PhD) (4 Credits)**

*Typically offered Spring*

Introduction to general equilibrium theory, welfare economics, and imperfect competition.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1025 Macroeconomics (PhD) (4 Credits)**

*Typically offered Fall*

Models of national income determination; sectorial inflation; labor markets, production theories, and aggregate supply models; supply and demand for money; foreign trade and balance of payments.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1026 Macroeconomics II (PhD) (4 Credits)**

*Typically offered Spring*

Classical and Keynesian macroeconomic thought, modern-day microeconomic theories of money-wage and price determinations, and reconstruction of macro theory.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1101 Appl Stat Econometric I (MA) (3 Credits)**

*Typically offered Spring*

Introduction to probability theory and statistics. Topics include discrete and continuous probability distributions, normal distribution, the use of t-statistics, hypothesis testing, confidence intervals, and analysis of variance. Familiarity with a regression software package is mandatory.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1102 Applied Statistics & Econometrics II (3 Credits)**

*Typically offered Spring*

Introduction to single-equation regression estimation; ordinary least-squares estimation, confidence intervals, and significance testing; lags, dummy variables; multicollinearity; autocorrelation; heteroscedasticity and variable selection. Students are required to use a standard computer regression package to test a model of their choosing.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1108 Income Distrib in U.S. (4 Credits)**

*Typically offered Fall*

Surveys theories of income distribution and empirical evidence for the United States. The first part gives a historical overview of inequality in the United States in the 20th century. Human capital, Marxism, internal labor market, dual labor market, and structural theories of income inequality are then surveyed along with their supporting evidence. Also covered are topics on screening, ability and earnings, discrimination, and growth and inequality.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

## **ECON-GA 1402 Money & Banking (MA) (3 Credits)**

*Typically offered Fall*

The role of money in the economy-monetary institutions, monetary theory (the old and new quantity and Keynesian theories), monetary policy goals, methods, and problems, with special emphasis on banking regulation.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 1501 Trade and Spatial Economics (4 Credits)***Typically offered Fall*

Introduction to trade and spatial economics. Covers classic Factor Proportions and Ricardian theories. Modern topics include: firms and trade, labor market dynamics, quantitative gravity and spatial models

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1502 Thry International Finan (PhD) (4 Credits)***Typically offered Spring*

Comparative advantage; endowment, mobility, allocation, and earnings of productive factors; trade resComparative advantage; endowment, mobility, allocation, and earnings of productive factors; trade restriction (tariffs, quotas); customs unions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1505 International Trade (MA) (3 Credits)***Typically offered Fall*

Comparative advantage; endowment, mobility, allocation, and earnings of productive factors; trade restriction (tariffs, quotas); customs unions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1506 Internatn'L Finance (MA) (3 Credits)***Typically offered Spring*

The balance of payments, foreign exchange markets, adjustment mechanisms, capital movements, gold and other monetary reserves, reforms of the system.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1601 Thry of Eco Dev I (PhD) (4 Credits)***Typically offered Fall*

The historical and contemporary process of transformation of less-developed economies, internal and international sources of and barriers to development; strategies for effective use of internal and external finance; growth theory and development; models of dualistic development, unemployment, and migration; problems of income distribution, population growth, education, and rural development.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1602 Economic Development II (PhD) (4 Credits)***Typically offered Spring*

Current topics in economic development in their theoretical, empirical, and policy contexts. Issues include the north-south dialogue, appropriate technology, the role and limitations of the state, population and development policy, urbanization, human resource development, and prospects for private and public foreign assistance.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1603 Econ Development I (MA) (3 Credits)***Typically offered Spring*

This course provides an overview of problems of growth and development, with an emphasis upon less developed countries, transition economies and industrialized countries undergoing extensive liberalization. It will examine the vigorous debates that have taken place regarding economic development. Why do some economies grow, while others do not? Are the great differences in the wealth of nations due mainly to differences in the quality of their institutions and economic policies?

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1605 Latin Amer Economics (3 Credits)***Typically offered Spring*

Provides an understanding of economic relationships in the Latin American-Caribbean region through an examination of the leading issues and key problems that these countries face in developing and modernizing their economies. Topics include a brief historical outline; a comparison of heterodox Latin American economic thought to neoclassical theories of growth and development; external equilibrium; foreign trade, balance of payments, exchange rates, foreign investments, and external debt.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1701 Labor Economics I (4 Credits)***Typically offered Fall*

Focuses on dynamic models of labor market behavior. Reviews dynamic optimization theory and develops the model of job market search. The baseline model for analyses of labor market dynamics at the industrial level and the search model are used to discuss estimation issues and to build partial equilibrium models of the labor market. Other models of equilibrium wage determination include signaling models, matching models, and models with asymmetric information and moral hazard (efficiency wages). Considers theory and empirical implications of the human capital investment model, with applications to occupational choice and the effect of cohort size on human capital investment and earnings outcomes.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1702 Labor Economics II (4 Credits)***Typically offered Fall*

Focuses on household decision making in both static and dynamic contexts. Develops models of family decision making using both neoclassical and bargaining theories. Examines the differences in the empirical implications of the two types of models. Considers labor supply issues and the economics of the marriage market, fertility, welfare programs, econometric issues, and endogenous sample selection.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1801 Indust Organization I (4 Credits)***Typically offered Fall*

Technological innovation, diffusion, research and development, firm behavior, market structure, and entry and exit of firms. Entrepreneurial choice. Schumpeterian competition. Welfare analysis of above topi

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 1802 Industrial Organization II (4 Credits)***Typically offered Spring*

Introduces standard and strategic models of market behavior and structure. Covers the firm, production and transaction costs, single-firm behavior, choice of quality and product differentiation, vertical integration and vertical restraints, static and dynamic oligopoly, supergames, and finite horizon models

**Grading:** GSAS Graded**Repeatable for additional credit:** No

**ECON-GA 2021 Financial Economics I (4 Credits)***Typically offered Fall*

Introduction to the study of financial markets and asset pricing from the perspective of economic theory. Topics include equilibrium economies with a representative agent; equilibrium economies with incomplete markets, borrowing constraints and transaction costs, limited stock market participation, private information, limited commitment; optimal security design; behavioral finance. While the stress is on modeling and tools, the course also introduces the empirical methodologies and the calibration techniques used in financial economics, as well as some of the most controversial evidence on asset prices.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2022 Financial Economics II (4 Credits)***Typically offered Fall and Spring*

Gives Ph.D. students an advanced survey of the field of financial economics and introduces them to some topics at the frontier of current research in financial economics. Discusses capital budgeting, capital structure, dividends, market for corporate control, bankruptcy and workouts, taxes, risk management, real options, signaling, general equilibrium approach to asset markets, microeconomics of banking, product market interactions, financial innovation, and comparative financial systems.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2023 Empirical Asset Pricing (4 Credits)***Typically offered Spring*

Introduction to empirical asset pricing.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2041 Evolution of Economic Thought (3 Credits)***Typically offered Fall*

Interrelations between changing social formations and economic thought, from prehistory and the Greco-Roman world to classical economics and the rise of modern capitalism in the West. Ends with the crisis of classicism and the emergence of neoclassical economics.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2050 Economics of Welfare, Justice, & Ethics (3 Credits)***Typically offered not typically offered*

Exploration of the interface between ethical theory and normative economics. Topics include the utilitarian foundation of modern welfare economics, economic basis of moral rules, interpersonal comparisons of utility, wealth maximization, social cost-benefit analysis, economic value of human life, and critique of utilitarianism.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2100 Econometrics I (4 Credits)***Typically offered Fall*

Concise introduction to probability theory and to the problem and methods of statistical inference as encountered and applied in econometrics: maximum likelihood theory, method of moments, method of least squares, and hypothesis testing.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2101 Econometrics II (PhD) (4 Credits)***Typically offered Spring*

Econometrics analysis of the general linear model; the estimation of distributed lag models; misspecification analysis; and models involving errors in variables.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2113 Game Theory I (4 Credits)***Typically offered Fall*

Introduction to noncooperative game theory. Covers Bayesian games, refinements of Nash equilibrium, repeated games, and optimal mechanism design.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2114 Experimental Economics (4 Credits)***Typically offered Fall*

Studies experimental methods and reviews the literature in an effort to give the student a working knowledge of experimental techniques. While the areas of application vary, the course is research oriented.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2115 Game Theory II (4 Credits)***Typically offered Spring*

Course on decision theory and cooperative microeconomics. Covers classical theory of individual choice, theory of social choice, mechanism design, Nash bargaining, and theory of cooperative games.

**Grading:** GSAS Graded**Repeatable for additional credit:** Yes**ECON-GA 2302 Financing Urban Govt (4 Credits)***Typically offered not typically offered*

The special character of public finance in complexly interrelated metropolitan communities operating with fragmented and multilayered governmental structures; the intergovernmental fiscal system and its functioning in urban areas; taxes and charges as means of financing urban public services and their economic and land-use effects; the financing of specific urban governmental functions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2305 Urban Economic Growth (3 Credits)***Typically offered not typically offered*

Explains the spatial aspects of economics and the problems and policies of urban economies. Students are taught to employ the tools of economic analysis to explain the economic structure of urban centers.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2401 Regulation of Financial Institutions (3 Credits)***Typically offered Fall of even numbered years*

Consideration of challenge facing regulators to design and operate an efficient and stable financial institutional framework in light of regulatory theory, historical developments, and current policy concerns. Focus is on the United States, but issues facing both developed and developing nations are also discussed.

**Grading:** GSAS Graded**Repeatable for additional credit:** No

**ECON-GA 2403 Adv Macroeconomics I (4 Credits)***Typically offered Fall*

Analyzes real models of economic fluctuations. Presents classical models, i.e., models for which equilibrium allocations are efficient, and nonclassical real models, including models with fiscal distortions, productive externalities, and imperfect competition.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2404 Adv Macroeconomics II (Growth & Distribution) (4 Credits)***Typically offered Spring*

Focuses on the monetary and financial aspects of economic fluctuations and business cycle models discussed in Advanced Macroeconomics I, by introducing money, nominal rigidities, and financial intermediation. Emphasis is on the role and effects of monetary policy, both in theory and data.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2610 Pol Econ of North-South Relations (4 Credits)***Typically offered occasionally*

Issues in restructuring the international economic system. Analyzes initiatives of the Western, socialist, and developing countries. Emphasis is on trade and monetary questions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 2620 Pol Econ Pacific Basin (4 Credits)***Typically offered occasionally*

Evaluates recent trends in East Asian and Pacific economic and political developments. The character of economic growth, the nature of the political systems, and implications of recent dynamism. Analyzes trends with discussion on three regions: Northeast Asia, Southeast Asia, and the Pacific Islands.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 3000 Reading & Research (0.5-6 Credits)***Typically offered Fall and Spring*

Students complete supervised research towards the fulfillment of dissertation or thesis requirements of a graduate program, or some other approved independent study

**Grading:** GSAS Graded**Repeatable for additional credit:** Yes**ECON-GA 3001 Topics in Economics: (2-4 Credits)***Typically offered occasionally*

Topics of current interest are examined in detail. Students are notified in advance of the topic(s) to be covered. Three or more sections are offered each semester, each covering a different topic.

**Grading:** GSAS Graded**Repeatable for additional credit:** Yes**ECON-GA 3002 Topics in Economics: (2-4 Credits)***Typically offered occasionally*

Topics of current interest are examined in detail. Students are notified in advance of the topic(s) to be covered. Three or more sections are offered each semester, each covering a different topic.

**Grading:** GSAS Graded**Repeatable for additional credit:** Yes**ECON-GA 3003 Microeconomics Workshop (4 Credits)***Typically offered occasionally*

Students, faculty members, and visitors present research in progress for discussion and critical comment.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** No**ECON-GA 3004 Microecon Research Wkshp (4 Credits)***Typically offered occasionally*

Students, faculty members, and visitors present research in progress for discussion and critical comment.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3005 Macroeconomics Workshop (4 Credits)***Typically offered occasionally*

Doctoral-level course consisting of a series of seminar presentations in macroeconomics by students, faculty, and guests. Emphasis is on research in progress. Topics include inflation, employment and labor markets, monetary and fiscal theory and policy, consumption and saving behavior, investment and capital formation, and aggregate supply and growth.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3006 Workshop in Macro (4 Credits)***Typically offered occasionally*

Doctoral-level course consisting of a series of seminar presentations in macroeconomics by students, faculty, and guests. Emphasis is on research in progress. Topics include inflation, employment and labor markets, monetary and fiscal theory and policy, consumption and saving behavior, investment and capital formation, and aggregate supply and growth.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3007 Appl Econometric Wkshp (4 Credits)***Typically offered occasionally*

Doctoral-level workshop consisting of a series of seminar presentations in applied economics by students, faculty, and guests. Emphasis is on issues involving panel data, macro-, development, and labor economics.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3008 Appl Econometrics Wkshp (4 Credits)***Typically offered occasionally*

Doctoral-level workshop consisting of a series of seminar presentations in applied economics by students, faculty, and guests. Emphasis is on issues involving panel data, macro-, development, and labor economics.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3009 Tps: (3 Credits)***Typically offered Spring*

This course introduces students to machine learning / artificial intelligence and its potential applications in economics. It covers topics such as classification, cross validation/model selection, tree-based methods, support vector machines, neural networks, unsupervised learning, reinforcement learning and an introduction to deep learning.

**Grading:** GSAS Graded**Repeatable for additional credit:** Yes

**ECON-GA 3101 Sem in Econometrics (4 Credits)***Typically offered Fall and Spring*

Doctoral-level course consisting of a series of seminar presentations in econometrics by guests, faculty, and students. Emphasis is on econometric methods and empirical research with a strong econometric component for cross section, panel, or time series data.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** No**ECON-GA 3103 C.E.S.S. Experimental Economics Workshop (2 Credits)***Typically offered occasionally*

Doctoral-level course consisting of a series of seminar presentations in experimental economics by guests, faculty, and students. Focused mostly on research with a laboratory experimental component, it also includes projects in behavioral economics, field experiments, and theoretical work inspired by experimental results.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** No**ECON-GA 3200 Special Projects in Econ Research (0.5-2 Credits)***Typically offered Fall and Spring*

Students integrate economic theory, empirical techniques, and analytical tools to solve real-world problems. Students undertake (1) a comprehensive and critical literature survey of economic theory, empirical techniques, and analytical tools to solve real-world problems. Students undertake (1) a comprehensive and critical literature survey of an applied topic in recent economic literature and (2) original analytical and/or empirical work on that topic.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 3300 Advanced Practical Training (0.5-2 Credits)**

Advanced Practical Training duties is used to and must significantly enhance students' ability to apply economic principles in practice. For successful completion, students must prepare a report in which they describe how the internship or practical training has enhanced their understanding of economics. All Master and PhD in Economics are not required to take a course in Advanced Practical Training. However, this course is offered in case students are interested in taking it as an elective.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3402 Colloquium On Market Institutions & Eco Procs (4 Credits)***Typically offered Fall and Spring*

Discussion of current research in the Austrian economics tradition. Themes treated include subjectivism, the market as dynamic process, and entrepreneurship. Ideas are applied to both micro and macro issues. Discusses papers written by students and by faculty from New York University and other universities.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 3501 Sem in Int'l Economics (4 Credits)***Typically offered Fall and Spring*

Advanced workshop for doctoral students pursuing dissertation topics in international trade and finance. Presentation of student research and dissertation proposals and original research papers by guests and members of the faculty.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** Yes**ECON-GA 3502 Seminar in Development Economics (4 Credits)***Typically offered Fall and Spring*

Advanced workshop for doctoral students pursuing dissertation topics in international trade and finance. Presentation of student research and dissertation proposals and original research papers by guests and members of the faculty.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 3503 Math and Econ Plus Code (2 Credits)**

This intensive course is focused on models of demand, matching models, and optimal transport methods, with various applications pertaining to labor markets, economics of marriage, industrial organization, matching platforms, networks, and international trade, from the crossed perspectives of theory, empirics and computation.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 3504 Math&Econ+Code Masterclass on Optimization in Economics (2 Credits)**

This intensive course is focused on the computation of competitive equilibrium with substitutes, which is at the core of surge pricing engines and allocation mechanisms. It will investigate diverse applications such as surge pricing, matching platforms and network congestion.

**Grading:** GSAS Pass/Fail**Repeatable for additional credit:** No**ECON-GA 4001 Tools for Computational Social Science (0 Credits)**

This course introduces several key tools which will be used for the rest of the certificate program. It covers the basics of the Python programming language, basic software engineering, and git as a version control tool.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 4002 Mathematical Foundations for Computational Social Science (3 Credits)**

This course introduces core concepts underlying computational social science, including, optimization, probability, and statistical modeling. We learn how to apply these concepts to a variety of social science questions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 4003 Data Skills for Computational Social Science (3 Credits)**

This course teaches the foundational skills necessary to do modern data analytics using the Python programming language. We assume that students have previously worked with Python. We will add to existing Python skills and teach the core scientific and data-specific libraries (numpy, scipy, matplotlib, and pandas). We will use these skills to analyze a variety of social science datasets and answer research and business questions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No**ECON-GA 4004 Dynamic Models for Computational Social Science (3 Credits)**

This course introduces dynamic processes, both deterministic and stochastic, as tools for answering questions in the social sciences. We apply these tools to a variety of current research questions.

**Grading:** GSAS Graded**Repeatable for additional credit:** No

**ECON-GA 4005 Machine Learning and Algorithms for Computational Social Science (3 Credits)**

This course teaches students both foundational and frontier algorithms and models used to analyze social science data. Analytical goals are data description, data reduction, and detection of relationships among variables, and ways to interpret those relationships in terms of underlying economic and social forces. The course teaches how estimated (i.e., “fit”) models can be used for prediction, forecasting, and possibly inference about cause and effect.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4011 Mathematical Methods for Economists I (1.5 Credits)**

The course begins with a quick review of basic methods of optimization theory, including necessary and sufficient conditions for optimality, the method of Lagrange multipliers and the Kuhn-Tucker conditions. These methods are required in the microeconomics and macroeconomics courses in the program. The course then develops the tools of real analysis and studies convergent sequences, compact sets, continuous and differentiable functions, the Heine-Borel Theorem and the Weierstrass Theorem. Several applications are presented, including one-dimensional discrete dynamic systems and price adjustment models, and existence of optimal solutions in economic problems. The course then goes on to study convex and concave functions, derive the basic results for unconstrained optimization, and provide some applications to risk theory. Finally, the course investigates the basic properties of convex sets and cones, proves Carathéodory's Theorem (on convex closures), and deduces some important results (such as Radon's Lemma and Helly's Intersection Theorem).

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4012 Mathematical Methods for Economists II (1.5 Credits)**

The second course goes deeper into convex analysis and optimization theory, and derives a number of core results such as the characterization of convex and quasiconvex functions, separating hyperplane theorems, Krein-Milman Theorem, the Kuhn-Tucker Theorem, and the Envelope Theorem. Optimization is required in the analysis of almost every economic model. Many economic applications are presented here, including some basic results in demand theory, Birkhoff's Theorem on bistochastic matrices and its consequences for measurement of income inequality, linear regression analysis, duality in linear programming, and job-matching models.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4021 Data and Computation I (1.5 Credits)**

This course is a hands-on approach to the study of open-source computational and data management tools now available online. Workhorses will be Python and affiliated programs for efficient calculations and numpy and pandas for data management. These tools are presented in ways designed to open doors for doing applied quantitative economics at the graduate level. The aim is to help students become literate in the open source ecology for doing machine learning with economic data and models at the graduate level. It is assumed that students are comfortable with linear algebra, multivariable calculus, and probability and statistics.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4022 Data and Computation II (1.5 Credits)**

This course is the sequel to Data and Computation I, and in the same spirit brings students up to speed with modern tools to manage economic data at a graduate level. The course is centered on the Python/numpy ecosystem, and has five parts. A first part introduces topics such as replicability through containerization, high performance computing, and cloud computing. A second part covers regression and model selection. A third part covers computational market design. A fourth part covers network problems. A fifth part covers dynamic discrete choice problems.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4031 Microeconomics I (1.5 Credits)**

This course studies how market outcomes are determined by the decision-making of individual consumers and firms in the economy. The focus for most of the course will be on the decisions of each side of the market separately, taking as given a set of prices which fix terms of trade. On the consumption side of the market, rigorous models of consumer preferences will be used to microfound demand curves and describe notions of complementarity and substitutability between different goods. On the production side, descriptions of production technologies coupled with an assumption of profit-maximization by firms will be used to generate supply curves. Finally, demand and supply will be brought together to determine market allocations in conditions of perfect competition, monopolistic competition, and monopoly, with particular emphasis on the welfare implications of each environment.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4032 Microeconomics II (1.5 Credits)**

This course is an introduction to the study of general equilibrium theory in economics. The approach adopted in the course aims at introducing the theory as the canonical theoretical structure for the study of market economies. Competitive equilibria are therefore studied as the main micro-foundation for macroeconomics and finance. The series of fundamental theorems which constitute the classic theory of general equilibrium, concerning existence, characterization, and welfare properties of competitive equilibria in frictionless economies, are introduced in their rigor, abstraction, and elegance. But the course will complement the classic theory with the modern analysis of financial market equilibria in dynamic economies with different kind of frictions, exposing students to fundamental conceptual notions like complete and incomplete markets, constrained inefficiency, moral hazard, adverse selection, bubbles. Topics will be enriched with a study of interesting applications of the concepts and results.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4041 Macroeconomics I (1.5 Credits)**

The first course in the macro sequence introduces the technical foundation for the study of macroeconomic models, introducing the theory and applications of dynamic programming. The first part of the course develops the technical tools on dynamic programming, including Bellman equations and the principle of optimality. On the second part, these tools are applied to the workhorse model of macroeconomics, the one sector growth model, covering its deterministic and stochastic versions. As another application of application of dynamic programming, the canonical labor search model is studied.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4042 Macroeconomics II (1.5 Credits)**

This course studies competitive macroeconomic models, with applications to growth and fiscal policies. The complete markets model is studied with rigor, showing its equivalence with the sequential environment, its recursive representation and the welfare theorems. We discuss the implementation of fiscal policies, focusing on normative recommendations. The overlapping generations model is introduced, with emphasis on its dynamic properties and the role of money and fiscal policy when agents have finite and overlapping lives.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4043 Macroeconomics III (1.5 Credits)**

Macroeconomics III builds on the real macroeconomic phenomena studied in Macroeconomics II, and extends the analysis to monetary and financial considerations, with an emphasis on short-term business cycle fluctuations. Students are introduced to a variety of macroeconomic models used to study the role of money and monetary policy, financial intermediation and high frequency macroeconomic fluctuations. We start with the introduction of macro economic models with money, such as the classical models of money in the utility function and cash in advance. We also study search based models of liquidity, which are the core of the macroeconomic study of financial securities. High frequency fluctuations are analyzed in the context of the real business cycle model and the New Keynesian model, the workhorse model for the analysis of demand-driven recessions and of fiscal and monetary counter-cyclical policies. To understand the role of financial intermediation and its impact on the macroeconomy, we study models of financial frictions and the canonical banking model of Diamond-Dybvig.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4044 Macroeconomics IV (1.5 Credits)**

This course extends the macro models developed in the earlier courses in the macro sequence, focusing on models that can be used to give quantitative answers to economic questions, such as asset pricing and its macro implications, unemployment and wealth inequality. The course provides a rigorous description of these models and discusses its empirical implications.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4051 Game Theory I (1.5 Credits)**

This course provides a rigorous treatment of the basic models and solution concepts of non-cooperative game theory primarily in a symmetric information setting. It begins with Normal form games and dominance arguments, mixed strategies, and the fundamental concept of Nash equilibrium. Next, the course discusses extensive form games, subgame perfect equilibrium, and other refinements of Nash equilibrium. Applications include models which are often used in applied economics, such as bargaining and repeated games. From a critical perspective, the course compares Nash equilibrium with reasoning based solution concepts: rationalizability, and level-k reasoning.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4052 Game Theory II (1.5 Credits)**

This course builds on Game Theory I and continues the presentation of non-cooperative games, with an emphasis on asymmetric information: Bayesian games, Bayesian equilibrium and associated refinements. Key applications include auctions, global games, cheap talk, and reputation formation. Basic cooperative solution concepts like the core, Nash bargaining solution and Shapley value are also introduced and connections with the non-cooperative perspective explored.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4061 Applied Microeconomics I (1.5 Credits)**

The first course in the applied micro sequence, covering the main statistical tools and questions in the field. The course emphasizes a hands-on approach, with analysis of primary data to replicate and extend existing research papers. It will implement and evaluate the core methods used in modern regression analysis for identifying causal effects: difference-in-differences, regression discontinuities and bunching, instrumental variables, and experiments. It will cover iconic papers in the field (such as those which measure the causal effects of education on earnings, or uncover labor supply elasticities), as well as frontier research projects in a variety of subfields, including innovation, migration, economic development, and economic history.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4062 Applied Microeconomics II (1.5 Credits)**

The course uses examples from the fields of labor, development, and public economics in order to illustrate econometric methods employed in model-based estimation, in which an explicit model of agents' decisions is the basis for the estimation of policy-invariant parameters. These estimates can then be used to perform (numerical) comparative statics exercises and counterfactual policy experiments. In addition to discussing the substantive details of each of the papers that we consider, we will present details of the econometric procedures utilized. In particular, the course discusses maximum likelihood estimation, nonlinear least squares, and the method of simulated moments.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4071 Econometrics I (1.5 Credits)**

This course introduces the core tools used for conducting empirical research in economics. The course will focus primarily on estimation and inference using linear regression and instrumental variables methods. Theory of estimation and inference will be developed rigorously. In addition, the course will cover important topics for empirical research, such as causal inference, random experiments, selection bias, and control variables. Practical issues will also be discussed, such as standard errors for dependent, heterogeneous, or clustered data, specification tests, and measurement error. Methods will be illustrated using numerous empirical applications across diverse fields of economics.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4072 Econometrics II (1.5 Credits)**

This course continues the econometrics sequence, turning to broader estimation paradigms and more advanced inference concepts. The course aims to give students a rigorous theoretical understanding along with a practical understanding of how to implement econometric methods. Topics include nonlinear estimation, maximum likelihood estimation, discrete choice models, generalized method of moments, bootstrapping, model selection, and panel data. Influential studies from labor economics and industrial organization will illustrate important concepts and methods.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4073 Econometrics III (1.5 Credits)**

This course includes topics at the frontier of econometrics including machine learning and simulation-based methods. The course aims to provide students with a broad overview of new methodologies and their practical applications in economics. Starting by surveying both classic and new methods for prediction, we then elaborate on how to use them to help us draw causal conclusions in specific economic contexts. We finish with an introduction to simulation-based methods.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4081 Industrial Organization I (1.5 Credits)**

This is the first part of a two course sequence in Industrial Organization. The primary focus of the course will be empirical, though theoretical concepts will be introduced and reviewed as needed. The main focus of this course is measuring markups and market power in a static setting. Topics include: estimation of supply and demand for homogenous and differentiated products; Economics of antitrust: merger evaluation and detection of collusion. Price Discrimination; Production Function Estimation, Measures of Productivity.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4082 Industrial Organization II (1.5 Credits)**

This is the second part of a two course sequence in Industrial Organization. It presumes you have completed the first part. The primary focus of the course will be empirical, though theoretical concepts will be introduced and reviewed as needed. This course extends the study of market power to settings with dynamic consumer behavior (durable goods, storable goods, switching costs, statedependence) and to settings with asymmetric information (such as auctions). We also study market power in the long run including endogenous entry and exit of firms, and in markets with vertical separation.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4091 Computational Dynamics (1.5 Credits)**

The solution of state-of-the-art quantitative models in economics and finance often requires numerical implementation on a computer. In this course, we will explore a range of computational methods used to solve such quantitative dynamic problems: Local approximations of equilibria in models for macro-policy analysis, global methods for approximating solutions to nonlinear decision problems, filtering techniques used in learning and estimation, discretization methods popular in financial economics, as well as neural network models used in data science. Students will implement each method using Python.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4101 International Economics (1.5 Credits)**

This course covers advanced topics in international trade and macroeconomics. The trade topics include fundamental models of trade flows and their quantitative implementation, the role of firms in international trade, and the welfare gains from international trade. The macro topics include business cycles in advanced and emerging economies, macroeconomic and financial crises, the determination of exchange rates, the special role of the dollar, currency unions, and sovereign debt and default. Each topic is motivated with empirical evidence and presents a relevant theoretical framework, which involves dynamic optimization, general equilibrium and strategic interaction.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4111 Financial Economics (1.5 Credits)**

This course builds the analytical and quantitative tools necessary to study the links between economics and finance, both in theory and in practice. It starts with the microeconomics of individual decision-making in a dynamic environment in which uncertainty and information about that uncertainty change over time, then adds the macroeconomics of how financial markets intermediate those decisions across economic agents and across time. The course combines the analytical tools needed to think clearly about uncertainty, dynamic optimization and equilibrium, with the quantitative tools of measurement, statistics, and computational algorithms using both Matlab and Python, needed to relate theoretical concepts to real-world data. Topics include: the role of preferences in dynamic consumption and portfolio choice; equilibrium asset pricing with both complete and incomplete markets; models of multi-period bond pricing; options and derivatives; and models of the equity premium.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4121 Research Practicum I (1.5 Credits)**

The research practicum course sequence brings students closer to the frontier of economics research. The goal is to introduce the student to cuttingedge research tailored to their specific interests. During the course, students have the opportunity to work closely with faculty on ongoing projects, or to critically evaluate the current research on a given topic.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No

**ECON-GA 4122 Research Practicum II (1.5 Credits)**

The research practicum course sequence brings students closer to the frontier of economics research. The goal is to introduce the student to cuttingedge research tailored to their specific interests. During the course, students have the opportunity to work closely with faculty on ongoing projects, or to critically evaluate the current research on a given topic.

**Grading:** GSAS Graded

**Repeatable for additional credit:** No