Undergraduate Economics Program

Carol B. Goldberg, Executive Director
Kathleen Conway, Senior Academic Advisor and Program Manager

Location: Tepper Quad, Suite 2400
Email: econprog@andrew.cmu.edu

Advising Appointment Online Scheduler: http://meetme.so/CMUEconomics

At its most fundamental level, economics is the study of how scarce resources are allocated. What will be produced and consumed, how much, and by whom? These questions are central to the well-being of people throughout the world. Economists identify, model, and analyze problems with the objective of developing practical and efficient solutions to challenges confronting society. Economists are also active participants in the processes and institutions through which economic policies are implemented. In the public arena sphere, economists contribute to design of programs and incentive systems to foster efficient implementation of policies. In the private sector, economists bring modeling and data-analytic skill to bear, both in identifying ways to enhance productive efficiency within the firm and in developing strategies to enhance effectiveness of the firm as it competes in the global marketplace. Increasingly, economists are taking advantage of advances in technology to design new exchange systems in applications as diverse as global electronic markets, kidney exchanges, pollution control, and school choice mechanisms.

Carnegie Mellon University enjoys a rich history of innovative research in the field of economics. The university has a distinctive culture that fosters collaborative, problem-oriented, theoretically rigorous, and empirically tested research. The success of this distinctive approach is manifest in the international recognition accorded past and present faculty, including nine Nobel Prizes in Economics. In the classroom, faculty bring the same rigorous, innovative approach to help develop the tremendous intellectual potential and analytic skills of students who are drawn to study economics at Carnegie Mellon. Project courses and hands-on applications in classes enable our students to gain valuable practical experience in honing their skills in economic reasoning, modeling, and data analysis.

The Undergraduate Economics Program has a unique position at Carnegie Mellon University. It is the sole undergraduate program that is a joint program of the Tepper School of Business and the Dietrich College of Humanities and Social Sciences. The combination of research strength and commitment to liberal arts and interdisciplinary studies provides our undergraduates with a world-class economics program.

Economics majors are considered members of both colleges and enjoy the full support and services of both. Undergraduate economics students should consult the program’s website for details about applicable Tepper and Dietrich academic policies and procedures.

Educational Objectives

The Undergraduate Economics Program offers a range of degrees in economics designed to develop strong analytical skills and a solid foundation in the discipline of economics. More specifically, measurable objectives for our economics curriculum are the following:

- Students should be able to identify, explain, and use economic concepts, theories, models, and data-analytic techniques.
- Students should acquire and use knowledge of economics, mathematics, statistics, and computing flexibly in a variety of contexts, providing the foundation for success in graduate studies and careers in the public and private sectors.
- Students should be able to apply their economic tools to formulate positions on a wide range of social and economic problems and engage effectively in policy debates.
- Students should use the investigative skills necessary for conducting original economic research and participating effectively in project teams.
- Students should be able to deliver effective presentations in which they combine visual communication design with oral arguments and/or the written word.

Academic Standards and Policies

Undergraduate economics students are in the unique position of belonging to two CMU colleges, Marianna Brown Dietrich College of Humanities and Social Sciences and the Tepper School of Business. To find a detailed description of the college and program policies governing economics students, please visit the program website (https://www.cmu.edu/tepper/programs/undergraduate-economics/curriculum/).

Advising

The Undergraduate Economics Program is committed to providing students with the opportunity to have meaningful and informative discussions about their academic, intellectual, and career interests with a wide range of advisors and mentors. Advising meetings are extended discussions which may address both immediate and long-term interests, concerns, and desires/needs. Students pursuing a degree in economics are assigned an economics advisor who meets with them on a regular basis. Any CMU undergraduate student interested in taking an economics courses is invited to meet with an economics advisor. To facilitate scheduling advising meetings, please use the online appointment scheduler (https://meetme.so/CMUEconomics/).

The economics curriculum is cumulative; higher-level courses build upon the foundations learned in the core courses. This results in students needing to be aware of course-sequencing and the schedule of classes. Students are encouraged to meet frequently with their Undergraduate Economics Program academic advisor to ensure that their courses fulfill the requirements towards their degree and are appropriately sequenced. Successful students check-in with their advisor frequently and seek the advice of their academic advisor in selecting courses, pursuing additional degrees, and planning ahead for study abroad.

First-Year Advising

First-year students who major in economics enter Carnegie Mellon University as Dietrich College students, and are assigned a Dietrich College Academic Advisory Center (http://www.cmu.edu/academic-advisory-center) (AAC) advisor. While the AAC advisors are the advisors of record until students formally declare their majors, students who are considering majoring in economics are encouraged to contact the Undergraduate Economics Program academic advisor so that they will have access to program resources; program-level advising; and the community of faculty, staff, and students.

First-year students are not expected to know which degree option they wish to pursue. For this reason, the first-year curricula are quite similar for the five primary degrees awarded by the program. As students become involved in their course work, participate in the extra- and co-curricular activities sponsored by the Undergraduate Economics Program, and have discussions with faculty and economics advisors, the decision of which degree to pursue becomes evident.

Study Abroad

The Undergraduate Economics Program encourages students to consider enriching their undergraduate experience by studying abroad at some point during their undergraduate tenure. Studying abroad is widely defined as either study, work, internship, volunteer, or research opportunities abroad during your college career. Studying abroad provides students with not only more awareness of cultural literacies, but it further enhances their education by providing them with the opportunity to compare and contrast different economies and regimes. Many students consider their study abroad experience to be a watershed moment in their studies. With a bit of careful planning, study abroad can be worked into most any economics student’s 4-year schedule.

Preparation for Professional School Programs

Many economics students will attend professional graduate school programs (e.g., DDS, JD, MBA, MD, MPP, M.Sc. Finance, etc.) immediately after graduation or within the first five years of earning their undergraduate degree. Students who are considering applying to professional graduate schools are encouraged to discuss their interests with an economics
advisor early in their career at CMU. The economics advisors can provide structure and information that are invaluable during a student’s intellectual and career exploration. Knowing that the choice of courses, student achievement, extra- and co-curricular activities, professional school entrance exam test scores (e.g., GMAT, LSAT, MCAT, etc.), and faculty recommendations are key determinants of acceptance into these varied programs, the economics advisors will help you plan your time at CMU.

Preparation for Ph.D. Programs in Economics

The Undergraduate Economics Program has been successful in preparing students for admission into the nation’s most competitive doctoral programs. The life of a researcher (whether in academia or in the private research sector) requires a set of skills that undergraduate students will begin to acquire through course work, research, and focused conversations with faculty and advisors. Doctoral programs in economics are looking for specific analytical skills. Key determinants of acceptance into these programs are the choice of courses, student achievement, research experience, graduate school entrance exam test scores (specifically the GRE), and faculty recommendations. Students who are considering pursuing a higher academic degree are encouraged to discuss their interests with an economics advisor early in their career at CMU. Interested students are encouraged to consider the B.S. in Economics and Mathematical Sciences curriculum.

Curriculum

In order to accommodate students’ wide variety of goals, five primary degree programs are available: Bachelor of Arts in Economics, Bachelor of Science in Economics and Mathematical Sciences (jointly administered by the Department of Mathematics and the Undergraduate Economics Program), Bachelor of Science in Economics and Statistics (jointly administered by the Department of Statistics and Data Science and the Undergraduate Economics Program), and Bachelor of Science in Economics and Politics (jointly administered by the Institute for Politics and Strategy and the Undergraduate Economics Program).

The five major degree programs have been designed to provide students with a solid understanding of the central theories and analytical tools of the field of economics, while maintaining the flexibility necessary to meet the needs of a diversity of career paths. The five degrees produce strong analytical thinkers who are able to model and analyze complex problems. Graduates of the Undergraduate Economics Program gain employment as economic analysts in both the private and public sectors; pursue advanced professional degrees in business, law, and public policy; as well as enter into Ph.D. programs in economics, statistics, finance, and related fields.

For students who major in other academic fields, additional major programs in Economics, Economics and Statistics, and Economics and Politics and a minor degree program in Economics are available.

Concentrations

The Undergraduate Economics Program offers concentration areas which allow students to specialize. Concentrations consist of groups of mutually reinforcing economics electives that build off the economics core curriculum. These focused sets of electives allow a student to explore a group of allied topics, and/or develop a specialized and advanced skill set appropriate for a desired career. To fulfill a concentration, students must take four courses from the designated set of electives; courses in the concentrations may count towards your elective requirements. Students are not required to complete a concentration in order to earn a degree. See the program website (https://www.cmu.edu/tepper/programs/undergraduate-economics/curriculum/) for more details.

Major Degree Requirements and Sample Schedules

In addition to completing a minimum 360 units and fulfilling both the Dietrich General Education requirements and all University requirements, recipients of an undergraduate degree in economics must complete courses in mathematics, probability and statistics, writing, economic theory, and economic analysis, as well as a set of advanced electives and other specialized courses. It is important for students to realize that degree requirements are actually the “minimum” set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Following the list of requirements for each degree are sample four-year course schedules for a student pursuing an undergraduate degree in economics. As there are many different ways of completing the requirements, students are strongly encouraged to meet with an economics advisor to tailor their courses to their own particular needs. Students are responsible for ensuring that they understand all of the program requirements and that they meet the necessary conditions for graduation. When planning course schedules, students must give consideration to all prerequisite and co-requisite requirements.

In addition to meeting university and college graduation requirements, the Undergraduate Economics Program has the additional requirement: Economics courses counting towards any economics primary degree, additional major, or minor must be completed with a grade of “C” or higher.

B.A. in Economics

The B.A. in Economics provides a strong foundation in economic analysis and quantitative methods. The curriculum’s breadth incorporates the study of political, historical, and social institutions so that students may use the economic toolkit to address the current challenges humanity faces. Built into the degree is the opportunity to study political, historical, cultural, and social institutions from other CMU departments; these courses are referred to as “Special Electives”. The capstone of the curriculum is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies. Students pursuing this degree will be well-equipped to pursue graduate work (professional and academic), enter directly into the business world, or pursue public service.

All economics courses counting towards an economics degree must be completed with a grade of “C” or higher.

B.A. in Economics Curriculum

<table>
<thead>
<tr>
<th>Total Number of Units for the Major:</th>
<th>157/166</th>
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<tbody>
<tr>
<td>Mathematics Prerequisites (19 units)</td>
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<tr>
<td>Courses</td>
<td>Units</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>10</td>
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<tr>
<td>21-256 Multivariate Analysis or 21-259 Calculus in Three Dimensions</td>
<td>9</td>
</tr>
<tr>
<td>Sophomore Economics Colloquium (3 units)</td>
<td>Units</td>
</tr>
<tr>
<td>73-210 Economics Colloquium I</td>
<td>3</td>
</tr>
<tr>
<td>Writing Requirement (9 units)</td>
<td></td>
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<tr>
<td>73-270 Professional Communication for Economists</td>
<td>9</td>
</tr>
<tr>
<td>Economic Theory Requirements (36 units)</td>
<td>Units</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-103 Principles of Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-240 Intermediate Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>Quantitative Analysis Requirements (27 Units)</td>
<td>Units</td>
</tr>
<tr>
<td>36-200 Reasoning with Data or 36-207 Probability and Statistics for Business Applications or 70-207 Probability and Statistics for Business Applications</td>
<td>9</td>
</tr>
<tr>
<td>73-265 Economics and Data Science</td>
<td>9</td>
</tr>
<tr>
<td>73-274 Econometrics I</td>
<td>9</td>
</tr>
<tr>
<td>Advanced Economics Electives (36 Units)</td>
<td></td>
</tr>
<tr>
<td>Students must take four advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495. Students have the option of earning a concentration (<a href="https://www.cmu.edu/tepper/programs/">https://www.cmu.edu/tepper/programs/</a></td>
<td></td>
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</tbody>
</table>
Standard Work (9 Units; 18 Units for students working on an honors Program)

Courses include special electives. Students should consult an academic advisor when choosing these courses.

Special Electives (18 Units)

Students must take two special elective courses in the humanities and social sciences. Students should consult the degree audit system for courses that satisfy the special electives requirement. The list below is a sample of the courses that qualify as special electives; this is not a full list of qualifying courses. Students should consult an academic advisor when choosing special electives.

Sample Schedule for B.A. in Economics

The sample schedule below is an illustration of how students might plan their four-year schedules. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pursue additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actually the "minimum" set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Sophomore</th>
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<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
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<tr>
<td>36-200 Reasoning with Data</td>
<td>21-256 Multivariate Analysis</td>
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<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>73-103 Principles of Microeconomics</td>
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<tr>
<td>73-102 Principles of Microeconomics</td>
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<tr>
<td>73-069 Economics: BaseCamp</td>
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B.S. in Economics

The B.S. in Economics provides a strong foundation in economic theory and advanced quantitative analysis. The curriculum focuses on using "real-world" data to forecast behavior and to investigate the relationships between observed phenomenon and economic models. Combining these sophisticated economic modeling data analytic skills with our wide range of upper-level economic electives provides students with a rigorous analytical foundation that will allow them to pursue any career that interests them. The capstone of the curriculum is the Senior Project course where students use their qualitative and quantitative skills to contribute to the body of knowledge in empirical, experimental, and/or theoretical studies. Students completing this degree will be well-equipped to pursue graduate work (professional and academic) or enter directly into the business world or public service.

All economics courses counting towards an economics degree must be completed with a grade of "C" or higher.

B.S. in Economics Curriculum

Total Number of Units for the Major: 167/176

Mathematics Requirement (29 Units)

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<tr>
<th>Units</th>
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<tbody>
<tr>
<td>21-120</td>
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<td>21-256</td>
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<td>21-240</td>
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Sophomore Colloquium (3 Units)

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<th>Units</th>
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<tr>
<td>73-210</td>
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Quantitative Analysis Requirements (27 Units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Economics and Data Science 73-265</th>
<th>Econometrics I 73-274</th>
<th>Econometrics II 73-374</th>
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<tbody>
<tr>
<td>9</td>
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</table>

Writing Requirement (9 Units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Professional Communication for Economists 73-270</th>
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Economic Theory Requirements (36 Units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Microeconomics 73-102</th>
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<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Macroeconomics 73-103</th>
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<tr>
<th>Units</th>
<th>Intermediate Microeconomics 73-230</th>
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<tr>
<th>Units</th>
<th>Intermediate Macroeconomics 73-240</th>
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Advanced Economics Electives (54 Units)

Students must take six advanced elective courses. Advanced elective courses are those numbered 73-300 through 73-495 (excluding Econometrics II). Students have the option of earning a concentration (https://www.cmu.edu/tepper/programs/undergraduate-economics/curriculum/concentrations/) by completing a set of interconnected electives. While a concentration area is not required for this degree, it is an additional option that allows students to explore a group of aligned topics and/or develop a specialized and advanced skill set appropriate for a desired career path. The electives required for this degree may count towards your concentration area. To fulfill a concentration, students must take four courses from the designated set of electives. Please make sure to consult an advisor when choosing these courses.

Senior Work (9 Units; 18 Units for students working on an honors thesis in economics)

<table>
<thead>
<tr>
<th>Units</th>
<th>Senior Project 73-497</th>
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<tbody>
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or 73-500 & 73-501 or 66-501 & 66-502

Tepper College Honors Thesis I H&SS Senior Honors Thesis I H&SS Senior Honors Thesis II

Note: Students who complete a Dietrich or Tepper Honors Thesis in economics may use 73-497 (Senior Project) as an advanced economics elective.

Sample Course Schedule for the B.S. in Economics

The sample schedule below is an illustration of how students might plan their four-year schedules. This schedule has been designed to highlight the following characteristics of the degree program: 1) the work load is roughly 45-50 units per semester, hence there is no need for course overloading; and 2) room has been built into the schedule that would allow students to pursue additional degrees and/or study abroad. It is important for students to realize that degree requirements are the actually the "minimum" set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

<table>
<thead>
<tr>
<th>Units</th>
<th>Fall</th>
<th>Spring</th>
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<tbody>
<tr>
<td>251</td>
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Economic Theory Requirements (36 Units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Microeconomics 73-102</th>
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<td>9</td>
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<table>
<thead>
<tr>
<th>Units</th>
<th>Principles of Macroeconomics 73-103</th>
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<table>
<thead>
<tr>
<th>Units</th>
<th>Intermediate Microeconomics 73-230</th>
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<table>
<thead>
<tr>
<th>Units</th>
<th>Intermediate Macroeconomics 73-240</th>
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Sophomore Colloquium (3 units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Economics Colloquium I 73-210</th>
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<td>3</td>
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Quantitative Analysis Requirements (36 Units)

<table>
<thead>
<tr>
<th>Units</th>
<th>Reasoning with Data 36-200</th>
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<table>
<thead>
<tr>
<th>Units</th>
<th>Introduction to Probability Theory 36-225</th>
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or 36-217 Probability Theory and Random Processes

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<thead>
<tr>
<th>Units</th>
<th>Probability 36-325</th>
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<tbody>
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or 21-325 Probability

Econometrics II 73-374

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<tr>
<th>Units</th>
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</table>

B.S. in Economics and Mathematical Sciences

The B.S. in Economics and Mathematical Sciences is a collaborative effort between the Department of Mathematical Sciences and the Undergraduate Economics Program. Combining advanced mathematics with advanced economic theory is the hallmark of this curriculum. The curriculum provides students with courses that complement and develop depth of understanding of economic theory, applied economics, and applied mathematics. This degree offers an integrated curriculum, guiding students through a program of coursework that exploits and builds upon the synergies between mathematics and economics. This degree program equips students with the mathematical tools that are essential for success in Ph.D. programs in economics; mathematics; and key functional areas of business including finance, accounting, marketing, and information systems. Students pursuing this degree will be well prepared for the beginning of their research careers in academia, government, and industry. There are a limited number of student openings in this program; interested students may apply as early as their sophomore year. Acceptance into the degree program is based on academic performance, rigor of coursework, and initiative while at Carnegie Mellon. Acceptance into the program is based on meeting the following requirements:

- Cumulative QPA of at least 3.5
- Earned a "B" or better in 21-127 or 21-128
- Earned a "B" or better in 21-241
- Completed 73-102
- Earned a "B" or better in 73-103
- Earned a "B" or better in either 73-230 or 73-240

In order to graduate with the B.S. in Economics and Mathematical Sciences, students must maintain a cumulative Q.P.A. of 3.33. All economics courses counting towards an economics degree must be completed with a grade of "C" or higher.

B.S. in Economics and Mathematical Sciences Curriculum

<table>
<thead>
<tr>
<th>Total Number of Units for the Major</th>
<th>251</th>
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<table>
<thead>
<tr>
<th>Economic Theory Requirements (36 Units)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-103 Principles of Macroeconomics</td>
<td>9</td>
</tr>
<tr>
<td>73-230 Intermediate Microeconomics</td>
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<tr>
<td>73-240 Intermediate Macroeconomics</td>
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<table>
<thead>
<tr>
<th>Sophomore Colloquium (3 units)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-210 Economics Colloquium I</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantitative Analysis Requirements (36 Units)</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-200 Reasoning with Data</td>
<td>9</td>
</tr>
<tr>
<td>36-225 Introduction to Probability Theory</td>
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or 36-217 Probability Theory and Random Processes | Units |
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<tbody>
<tr>
<td>or 21-325 Probability</td>
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</table>

or 73-265 Economics and Data Science            | 9     |

| 73-274 Econometrics I                          | 9     |
| 73-374 Econometrics II                         | 9     |
Mathematical Sciences Requirements (85 Units)

<table>
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<th>Course</th>
<th>Units</th>
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<tr>
<td>21-120</td>
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<tr>
<td>21-122</td>
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<tr>
<td>21-127</td>
<td>10</td>
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<tr>
<td>21-228</td>
<td>9-12</td>
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<tr>
<td>or 15-251</td>
<td>9-12</td>
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<tr>
<td>21-241</td>
<td>10</td>
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<tr>
<td>21-259</td>
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<td>or 21-256</td>
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<tr>
<td>or 21-268</td>
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<tr>
<td>21-355</td>
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<tr>
<td>21-356</td>
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Programming Requirement (10 Units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>15-110</td>
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Writing Requirement (9 Units)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>73-270</td>
<td>9</td>
</tr>
</tbody>
</table>

Advanced Economic Electives (27 Units)

Students must take three advanced economics elective courses. Advanced Elective courses are those courses numbered 73-300 through 73-495, (excluding 73-374 Econometrics II). Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability. Students have the option of earning a concentration (https://www.cmu.edu/tepper/programs/undergraduate-economics/curriculum/concentrations/) by completing a set of interconnected electives. While a concentration area is not required for this degree, it is an additional option that allows students to explore a group of aligned topics and/or develop a specialized and advanced skill set appropriate for a desired career path. The electives required for this degree may count towards your concentration area. To fulfill a concentration, students must take four courses from the designated set of electives. Please make sure to consult an advisor when choosing these courses.

Recommended Advanced Economics Electives:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-315</td>
<td>9</td>
</tr>
<tr>
<td>73-338</td>
<td>9</td>
</tr>
<tr>
<td>73-347</td>
<td>9</td>
</tr>
<tr>
<td>73-365</td>
<td>9</td>
</tr>
<tr>
<td>73-421</td>
<td>9</td>
</tr>
</tbody>
</table>

Mathematical Science Depth Electives (27 Units)

Students must take three advanced mathematics depth courses. Students are encouraged to work with their advisors to structure a set of courses which meet these requirements based on their particular interests, subject to course availability.

Recommended Mathematical Science Depth Electives:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-270</td>
<td>9</td>
</tr>
<tr>
<td>21-292</td>
<td>9</td>
</tr>
<tr>
<td>21-301</td>
<td>9</td>
</tr>
<tr>
<td>21-341</td>
<td>9</td>
</tr>
<tr>
<td>21-369</td>
<td>12</td>
</tr>
<tr>
<td>21-370</td>
<td>9</td>
</tr>
<tr>
<td>21-371</td>
<td>9</td>
</tr>
<tr>
<td>21-393</td>
<td>9</td>
</tr>
<tr>
<td>21-420</td>
<td>9</td>
</tr>
<tr>
<td>21-484</td>
<td>9</td>
</tr>
</tbody>
</table>

Note: Only one of the following courses may count towards the required Mathematical Sciences Depth Electives: or 21-366 Topics in Applied Mathematics.

Senior Work (9 units; 18 units for students completing an honors thesis in economics)

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>73-497</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>or 73-500 or 73-501</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Sample Course Schedule for the B.S. in Economics and Mathematical Sciences

The sample schedule below is an illustration of how students might plan their four-year schedules. This schedule has been designed to highlight the following characteristics of the degree program: 1) the workload is roughly 45-50 units per semester, hence there is no need for course overloading; 2) room has been built into the schedule that would allow students to pursue additional degrees and/or study abroad; and 3) the demands of this degree require students to carefully plan their degree program while keeping in mind the college-level and university-level graduation requirements. It is important for students to realize that degree requirements are the actual “minimum” set of degree requirements. In fact, most economics students take more courses in their major than is strictly required.

Freshman

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>15-110 Principles of Computing</td>
<td>21-122 Integration and Approximation</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>21-256 Multivariate Analysis</td>
<td>73-210 Economics: BaseCamp</td>
</tr>
<tr>
<td>36-200 Reasoning with Data</td>
<td>73-103 Principles of Macroeconomics</td>
<td>-----</td>
</tr>
<tr>
<td>73-060 Economics: BaseCamp</td>
<td>-----</td>
<td>73-230 Intermediate Microeconomics</td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>73-240 Intermediate Macroeconomics</td>
</tr>
<tr>
<td>-----</td>
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</tr>
</tbody>
</table>

*In each semester, ----- represents courses not directly required for the major. Please note that students pursuing the B.S. in Mathematical Sciences and Economics must fulfill the Mellon College General Education requirements and not the Dietrich College General Education requirements.

Sophomore

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-260 Differential Equations</td>
<td>21-355 Principles of Real Analysis I</td>
<td>73-497 Senior Project</td>
</tr>
<tr>
<td>73-374 Econometrics II</td>
<td>Economics Elective</td>
<td>21-228 Discrete Mathematics</td>
</tr>
<tr>
<td>Economics Elective</td>
<td>Mathematics Elective</td>
<td>-----</td>
</tr>
<tr>
<td>Mathematics Elective</td>
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</tbody>
</table>

Junior

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-270 Introduction to Mathematical Finance</td>
<td>21-355 Principles of Real Analysis I</td>
<td>73-497 Senior Project</td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
<td>73-374 Econometrics II</td>
<td>Economics Elective</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>21-370 Discrete Time Finance</td>
<td>-----</td>
</tr>
<tr>
<td>21-341 Linear Algebra</td>
<td>21-371 Functions of a Complex Variable</td>
<td>-----</td>
</tr>
<tr>
<td>21-369 Numerical Methods</td>
<td>21-393 Operations Research II</td>
<td>-----</td>
</tr>
<tr>
<td>21-420 Continuous-Time Finance</td>
<td>21-484 Graph Theory</td>
<td>-----</td>
</tr>
</tbody>
</table>

Senior

<table>
<thead>
<tr>
<th>Course</th>
<th>Fall</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-270 Introduction to Mathematical Finance</td>
<td>21-355 Principles of Real Analysis I</td>
<td>73-497 Senior Project</td>
</tr>
<tr>
<td>21-292 Operations Research I</td>
<td>73-374 Econometrics II</td>
<td>Economics Elective</td>
</tr>
<tr>
<td>21-301 Combinatorics</td>
<td>21-370 Discrete Time Finance</td>
<td>-----</td>
</tr>
<tr>
<td>21-341 Linear Algebra</td>
<td>21-371 Functions of a Complex Variable</td>
<td>-----</td>
</tr>
<tr>
<td>21-369 Numerical Methods</td>
<td>21-393 Operations Research II</td>
<td>-----</td>
</tr>
<tr>
<td>21-420 Continuous-Time Finance</td>
<td>21-484 Graph Theory</td>
<td>-----</td>
</tr>
</tbody>
</table>

B.S. in Economics and Politics

Politics and economics are deeply interconnected. Political institutions and decision-making impact economic growth, income distribution, and many other aspects of economic life. Both fiscal and monetary policies affect the economy, but these policies are often employed with political considerations in mind and can influence political activity. Conversely, economic outcomes shape political preferences and policy choices. The overlap between these two disciplines is endless. For example, while the United Nations is often thought of in purely political terms, the Security Council can and does impose sanctions on countries-an example of an economic policy used for political change.

The Economics and Politics major is offered jointly between the Undergraduate Economics Program (https://www.cmu.edu/tepper/programs/undergraduate-economics/) (UEP) and the Institute for Politics and Strategy (https://www.cmu.edu/ips/). Students are equal members of both academic units and receive advising from both units. The major will appeal to any student interested in the design, evaluation, and political implementation of policy. It will be especially attractive to students considering careers in politics, government agencies, political and business consulting, lobbying, or the law.

The BS in Economics and Politics is an interdisciplinary major. The major will develop the political context and underpinnings of economic policy making. It will explore how political institutions resolve the tradeoffs and
disagreements associated with policymaking and how they can facilitate or impede desirable economic outcomes.

IPS strengths lie in topics like national security, grand strategy, and globalization. Economic policy is just one facet of grand strategy, through which an administration pursues domestic and international goals. This major will also address key issues such as the complementarity between the multilateral economic institutions such as the IMF and World Bank and the use of economic coercion, and enable students to understand economic statecraft more broadly. Whether coercion is successful depends not just on the levers of power but on also on variations in authoritarian regime structure, and complex linkages in the international economy. This is also important for our understanding of the relationship between international economics on human rights practices, extending even to how treaty commitments can facilitate compliance with a global initiative to combat climate change. And, not least important, there is broad recognition that the viability of the "Euro Zone" depends on whether the political-economic agreements necessary to mitigate institutional weaknesses are politically feasible or destined to failure.

Economics and Politics is available as both a primary and additional major.

Curriculum

Students must earn a grade of "C" or better in all courses taken in the Department of Economics (73-xxx).

Prerequisites

Students must complete all of the following courses.

21-120 Differential and Integral Calculus 10
or 21-112 Integral Calculus 9
36-200 Reasoning with Data 9

Foundations (48 units)

Students must complete all of the following courses.

21-256 Multivariate Analysis 9
or 21-259 Calculus in Three Dimensions 9
73-102 Principles of Microeconomics 9
73-103 Principles of Macroeconomics 9
84-104 Decision Processes in American Political Institutions 9
84-275 Comparative Politics 9
73-210 Economics Colloquium I 3

Core (63 units)

Students must complete all of the following courses.

73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-265 Economics and Data Science 9
73-274 Econometrics I 9
84-265 Political Science Research Methods 9
84-326 Theories of International Relations 9
84-310 International Political Economy 9

Communication (9 units)

Students must complete one course from the following list.

73-270 Professional Communication for Economists 9
84-250 Writing for Political Science and Policy 9

Electives (27 units)

Majors are required to take 27 units (three courses) from the elective lists below. At least one course (9 units) must be taken from Economics (73-xxx) and at least one course (9 units) must be taken from the Institute for Politics and Strategy (84-xxx). Students may complete electives through coursework in the Carnegie Mellon University Washington Semester Program (CMU/WSP) (https://www.cmu.edu/ips/cmuwsp/) Politics and Public Policy elective sequence.

Economics Electives

73-328 Health Economics 12
73-332 Political Economy 9
73-338 Financial Crises and Risk 9
73-352 Public Economics 9
73-353 Financial Regulation in the Digital Age 9
73-359 Benefit-Cost Analysis 9
73-365 Firms, Market Structures, and Strategy 9
73-421 Emerging Markets 9
73-427 Sustainability, Energy, and Environmental Economics 9

Politics and Strategy Electives

84-307 Economic and Political History of Contemporary China 9
84-308 Political Economy of Latin America Var.
84-309 Political Behavior 9
84-311 International Development: Theory and Praxis 9
84-313 International Organizations and Law 9
84-318 Politics of Developing Nations 9
84-319 U.S. Foreign Policy and Interventions in World Affairs 9
84-320 Global Perspectives on International Affairs 6
84-322 Nonviolent Conflict and Revolution 9
84-323 War and Peace in the Contemporary Middle East 9
84-324 The Future of Democracy 9
84-325 Contemporary American Foreign Policy 9
84-327 Repression and Control in Dictatorships 9
84-350 America and the World 6
84-352 Representation and Voting Rights 9
84-362 Diplomacy and Statecraft 9
84-363 Comparative Legal Systems 9
84-364 Comparative Presidential Behavior: Leadership, Personality, and Decision Making 9
84-366 The American Presidency 9
84-369 Decision Science for International Relations 9
84-370 Global Nuclear Politics 9
84-372 Space and National Security 9
84-373 Emerging Technologies and the Law 9
84-380 US Grand Strategy 9
84-382 Conflicts in the Middle East: Iran, Iraq, and Proxy Warfare 9
84-386 The Privatization of Force 9
84-387 Technology and Policy of Cyber War 9
84-388 Concepts of War and Cyber War 6
84-389 Terrorism and Insurgency 9
84-390 Social Media, Technology, and Conflict 9
84-393 Legislative Decision Making: US Congress 6
84-402 Judicial Politics and Behavior 9
84-405 The Future of Warfare 9
84-414 International and Subnational Security 9
84-421 Advanced Topics in American Politics 9

CMU/WSP Politics and Public Policy Electives

84-330 The Shading of Democracy: The Influence of Race on American Politics 6
84-331 Money, Media, and the Power of Data in Decisionmaking 6
84-332 Effects of US Policy on Businesses: Perspectives of Asian Americans 6
84-333 Power and Levers for Change in Washington, DC 12
84-334 Presidential Power in a Constitutional System 6
84-335 Intelligence and Policy 6
84-336 Implementing Public Policy: From Good Idea To Reality 12
84-337 Biomedical Science Research, Policy, and Governance 6
84-338 Political News Coverage in the Era of Trump, Twitter, and "Fake News" 6
84-339 Seminar in Public Policy Research 12
84-343 Language and Power: How to Understand and Use Political Speech 6
84-346 Legal Issues in Public Administration 6
84-348 Advocacy, Policy and Practice 6
Additional Electives
19-411 Science and Innovation Leadership for the 21st Century: Firms, Nations, and Tech 9
19-425 Sustainable Energy for the Developing World 9
70-365 International Trade and International Law 9
70-430 International Management 9
79-280 Coffee and Capitalism 9
79-318 Sustainable Social Change: History and Practice 9
80-135 Introduction to Political Philosophy 9
80-136 Social Structure, Public Policy & Ethics 9
80-321 Causation, Law, and Social Policy 9
80-335 Social and Political Philosophy 9
80-348 Health, Human Rights, and International Development 9
80-447 Global Justice 9
88-366 Behavioral Economics of Poverty and Development 9
88-419 International Negotiation 9
88-444 Public Policy and Regulations 9

CAPSTONE (15-21 units)
Students must complete all of the following courses.
84-450 Policy Seminar 6
12 units if taken during CMU/WSP, 6 units if taken in Pittsburgh
73-497 Senior Project or Senior Honors Thesis 9

SAMPLE Four Year Plan
These sample curricula represent a plan for completing the requirements for the B.S. in Economics and Politics. Economics and Politics students are encouraged to spend a semester studying and interning in Washington, DC, through the CMU/WSP (http://www.cmu.edu/psp/cmuwsp/), and/or study abroad. The plan below demonstrates that a semester off-campus fits well into the curriculum. Students may declare the BS in Economics and Politics as early as the second semester of the freshman year and should consult frequently with the Economics and Politics advisors about their course of study. Please note that this is only a sample plan of study and not the only possible plan of study. The Economics and Politics major and Dietrich College General Education curricula provide a high degree of flexibility in sequencing and coursework. Double counting between the major and General Education requirements is unlimited. The plan below shows a very conservative view of double counting.

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Sophomore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>21-256 Multivariate Analysis</td>
</tr>
<tr>
<td>36-200 Reasoning with Data</td>
<td>73-103 Principles of Microeconomics</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>84-275 Comparative Politics</td>
</tr>
<tr>
<td>84-104 Decision Processes in American Political Institutions</td>
<td>Foundations of Communications (First Year Writing)</td>
</tr>
<tr>
<td>Grand Challenge Seminar</td>
<td>Disciplinary Perspectives: Humanities</td>
</tr>
<tr>
<td>99-101 Computing @ Carnegie Mellon</td>
<td></td>
</tr>
</tbody>
</table>

B.S. in Economics and Statistics

Samantha Nielsen, Statistics & Data Science Senior Academic Advisor
Kathleen Conway, Economics Senior Academic Advisor

Carol Goldburg, Executive Director, Undergraduate Economics Program
Statistics & Data Science Location: Baker Hall 332
statadvising@andrew.cmu.edu (statadvising@stat.cmu.edu)
Economics Location: Tepper 2400
econprog@andrew.cmu.edu

The B.S. in Economics and Statistics is jointly advised by the Department of Statistics and Data Science and the Undergraduate Economics Program.

The major in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. With joint curriculum from the Department of Statistics and Data Science, and the Undergraduate Economics Program, the major provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

All economics courses counting towards an economics degree must be completed with a grade of "C" or higher.

The requirements for the B.S. in Economics and Statistics are the following:

I. Prerequisites 38-39 units

1. Mathematical Foundations 38-39 units

   Calculus
   21-120 Differential and Integral Calculus 10

   and one of the following:
   21-256 Multivariate Analysis 9
   21-259 Calculus in Three Dimensions 9
   21-268 Multidimensional Calculus 10

   Note: Passing the MSC 21-120 assessment test is an acceptable alternative to completing 21-120.

   Note: Taking/having credit for both 21-111 and 21-112 is equivalent to 21-120. The Mathematical Foundations total is then 48-49 units. The Economics and Statistics major would then total 201-211 units.

Linear Algebra
One of the following three courses:
   21-240 Matrix Algebra with Applications 10
   21-241 Matrices and Linear Transformations 10
   21-242 Matrix Theory 10

   Note: 21-241 and 21-242 are intended only for students with a very strong mathematical background.

II. Foundations 18-36 units

2. Economics Foundations 18 units
   73-102 Principles of Microeconomics 9
   73-103 Principles of Macroeconomics 9

3. Statistical Foundations 9-18 units

   Sequence 1 (For students beginning their freshman or sophomore year)

   Beginning*
   Choose one of the following courses:
   36-200 Reasoning with Data 9
   3670-207 Probability and Statistics for Business Applications 9
36-220 Engineering Statistics and Quality Control 9
36-247 Statistics for Lab Sciences 9

Note: Students who enter the program with 36-225 or 36-226 should discuss options with an advisor. Any 36-300 or 36-400 level course in Data Analysis that does not satisfy any other requirement for the Economics and Statistics Major may be counted as a Statistical Elective.

**All Special Topics are not offered every semester, and new Special Topics are regularly added. See section 5 for details.

Intermediate*
Choose one of the following courses:
36-202 Methods for Statistics & Data Science ** 9
36-208 Regression Analysis 9
36-290 Introduction to Statistical Research Methodology 9
36-309 Experimental Design for Behavioral & Social Sciences 9

* Or extra data analysis course in Statistics
** Must take prior to 36-401 Modern Regression, if not, an additional Advanced Statistics Elective is required.

Advanced Statistics Elective
Choose two of the following courses:
36-303 Sampling, Survey and Society 9
36-311 Statistical Analysis of Networks 9
36-313 Statistics of Inequality and Discrimination 9
36-315 Statistical Graphics and Visualization 9
36-461 Special Topics: Statistical Methods in Epidemiology 9
36-462 Special Topics: Methods of Statistical Learning 9
36-463 Special Topics: Multilevel and Hierarchical Models 9
36-464 Special Topics: Applied Multivariate Methods 9
36-465 Special Topics: Conceptual Foundations of Statistical Learning 9
36-466 Special Topics: Statistical Methods in Finance 9
36-467 Special Topics: Data over Space & Time 9
36-468 Special Topics: Text Analysis 9
36-469 Special Topics: Statistical Genomics and High Dimensional Inference 9
36-490 Undergraduate Research 9
36-493 Sports Analytics Capstone 9
36-497 Corporate Capstone Project 9

Sequence 2 (For students beginning later in their college career)

Advanced Statistics Electives
Choose three of the following courses:
36-303 Sampling, Survey and Society 9
36-311 Statistical Analysis of Networks 9
36-313 Statistics of Inequality and Discrimination 9
36-315 Statistical Graphics and Visualization 9
36-461 Special Topics: Statistical Methods in Epidemiology 9
36-462 Special Topics: Methods of Statistical Learning 9
36-463 Special Topics: Multilevel and Hierarchical Models 9
36-464 Special Topics: Applied Multivariate Methods 9
36-465 Special Topics: Conceptual Foundations of Statistical Learning 9
36-466 Special Topics: Statistical Methods in Finance 9
36-467 Special Topics: Data over Space & Time 9
36-468 Special Topics: Text Analysis 9
36-469 Special Topics: Statistical Genomics and High Dimensional Inference 9
36-490 Undergraduate Research 9
36-493 Sports Analytics Capstone 9
36-497 Corporate Capstone Project 9

**All Special Topics are not offered every semester, and new Special Topics are regularly added. See section 5 for details.

III. Disciplinary Core 126 units

1. Economics Core 45 units
73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-270 Professional Communication for Economists 9
73-265 Economics and Data Science 9
73-274 Econometrics I 9
73-374 Econometrics II 9

2. Statistics Core 36 units
36-225 Introduction to Probability Theory* # 9
36-226 Introduction to Statistical Inference or 36-326 Mathematical Statistics (Honors) 9
36-401 Modern Regression 9
36-402 Advanced Methods for Data Analysis 9

*In order meet the prerequisite requirements for the major, a grade of C or better is required in 36-225 (or equivalents), 36-226 or 36-401 and 36-402.

It is possible to substitute 36-218, 36-219 or 21-325 for 36-225. 36-225 is the standard introduction to probability, 36-219 is tailored for engineers and computer scientists, 36-218 is a more mathematically rigorous class for Computer Science students and more mathematically advanced Statistics students (Statistics students need advisor approval to enroll), and 21-325 is a rigorous Probability Theory course offered by the Department of Mathematics.

3. Statistical Computing 9 units
36-350 Statistical Computing 9

4. Advanced Electives 36 units
Students must take two advanced Economics elective courses (numbered 73-300 through 73-495, excluding 73-374 ) and two (or three - depending on previous coursework) from Section 3) advanced Statistics elective courses (numbered 36-303, 36-311, 36-313, 36-315, 36-46x, 36-490, 36-493 or 36-497).

Students pursuing a degree in Economics and Statistics also have the option of earning a concentration area (https://www.cmu.edu/tpper/programs/undergraduate-economics/curriculum/concentrations/) in Economics by completing a set of interconnected electives. While a concentration area is not required for this degree, it is an additional option that allows students to explore a group of aligned topics and/or develop a specialized and advanced skill set appropriate for a desired career path. The electives required for this degree may count towards your concentration area. To fulfill a concentration, students must take four courses from the designated set of electives. Please make sure to consult an advisor when choosing these courses.

Total number of units for the major 191-201 units
Total number of units for the degree 360 units

Professional Development
While not required, students are strongly encouraged to take advantage of professional development opportunities and/or coursework. One option is 73-210 Economics Colloquium I, a fall-only course that provides information about careers in Economics, job search strategies, and research opportunities. The Department of Statistics and Data Science also offers a series of workshops pertaining to resume preparation, graduate school applications, careers in the field, among other topics. Students should also take advantage of the Career and Professional Development Center.

Additional Major in Economics and Statistics
Students who elect Economics and Statistics as an additional major must fulfill all Economics and Statistics degree requirements. Majors in many other programs would naturally complement an Economics and Statistics Major, including Tepper's undergraduate business program, Social and Decision Sciences, Policy and Management, and Psychology.

With respect to double-counting courses, it is departmental policy that students must have at least six courses [three Economics (73-xxx) and three Statistics (36-xxx)] that do not count for their primary major. If students do not have at least three ECON and three STA classes, they will
need to take additional advanced data analysis or economics electives, depending on where the double-counting issue is.

Students are advised to begin planning their curriculum (with appropriate advisors) as soon as possible. This is particularly true if the other major has a complex set of requirements and prerequisites or when many of the other major’s requirements overlap with the requirements for a major in Economics and Statistics.

Many departments require Statistics courses as part of their Major or Minor programs. Students seeking transfer credit for those requirements from substitute courses (at Carnegie Mellon or elsewhere) should seek permission from their advisor in the department setting the requirement. The final authority in such decisions rests with the Department of Statistics and Data Science. The Department of Statistics and Data Science does not provide approval or permission for substitution or waiver of another department’s requirements.

If a waiver or substitution is made in the home department, it is not automatically approved in the Department of Statistics and Data Science. In many of these cases, the student will need to take additional courses to satisfy the Economics and Statistics major requirements. Students should discuss this with a Statistics advisor when deciding whether to add an additional major in Economics and Statistics.

Sample Program

The following sample program illustrates one way to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see footnotes below the schedule).

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Sophomore</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
</tr>
<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>36-202 Methods for Statistics &amp; Data Science</td>
</tr>
<tr>
<td>36-200 Reasoning with Data</td>
<td>21-256 Multivariate Analysis</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>73-103 Principles of Macroeconomics</td>
</tr>
<tr>
<td>73-900 Economics BaseCamp *not required</td>
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</table>

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<thead>
<tr>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
</tr>
<tr>
<td>36-401 Modern Regression</td>
<td>73-270 Professional Communication for Economists</td>
</tr>
<tr>
<td>73-374 Econometrics II</td>
<td>-----</td>
</tr>
</tbody>
</table>

*In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Prospective PhD students are advised to add 21-127 fall of sophomore year, replace 21-240 with 21-241, add 21-260 in spring of junior year and 21-355 in fall of senior year.

Dual Degree in Economics

A student pursuing a primary degree outside of the department may obtain a dual degree by completing all of the requirements for the B.S. in Economics or the B.S. in Economics and Statistics along with the Dietrich College general education requirements. In addition, the student’s total units completed must be at least 90 units in excess of the requirement for the student’s other degree(s) or at least 450 units, whichever is greater. Interested students should meet with an economics advisor.

Additional Major in Economics

All university students are eligible to pursue an additional major in economics in conjunction with a major in any department in the university other than economics. The requirements for the Additional Major in Economics are the same as those for the B.S. in Economics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics are asked to take additional advanced economics electives.

Additional Major in Economics and Politics

All university students are eligible to pursue a major in economics and politics in conjunction with a major in any department in the university other than economics or the Institute for Politics and Strategy. The requirements for the Additional Major in Economics and Politics are the same as those for the B.S. in Economics and Politics, except that the Dietrich College General Education requirements are waived. In order to avoid “double counting” issues, students are encouraged to meet with an economics or institute for Politics and Strategy advisor. When courses are shared across degrees, students pursuing an Additional Major in Economics and Politics are asked to take additional electives.

Additional Major in Economics and Statistics

Samantha Nielsen, Statistics & Data Science Senior Academic Advisor
Kathleen Conway, Economics Senior Academic Advisor

Carol Goldburg, Executive Director, Undergraduate Economics Program
Statistics & Data Science Location: Baker Hall 132
Economics Location: Tepper 2400
econprog@andrew.cmu.edu
The B.S. in Economics and Statistics is jointly advised by the Department of Statistics and Data Science and the Undergraduate Economics Program.

The major in Economics and Statistics provides an interdisciplinary course of study aimed at students with a strong interest in the empirical analysis of economic data. With joint curriculum from the Department of Statistics and Data Science and the Undergraduate Economics Program, the major provides students with a solid foundation in the theories and methods of both fields. Students in this major are trained to advance the understanding of economic issues through the analysis, synthesis and reporting of data using the advanced empirical research methods of statistics and econometrics. Graduates are well positioned for admission to competitive graduate programs, including those in statistics, economics and management, as well as for employment in positions requiring strong analytic and conceptual skills - especially those in economics, finance, education, and public policy.

All economics courses counting towards an economics degree must be completed with a grade of “C” or higher.

The requirements for the B.S. in Economics and Statistics are the following:

I. Prerequisites 38-39 units

1. Mathematical Foundations 38-39 units

Calculus

21-120 Differential and Integral Calculus 10

and one of the following:

21-256 Multivariate Analysis 9
21-259 Calculus in Three Dimensions 9
21-268 Multidimensional Calculus 10

Note: Passing the MSC 21-120 assessment test is an acceptable alternative to completing 21-120.

Note: Taking/having credit for both 21-111 and 21-112 is equivalent to 21-120. The Mathematical Foundations total is then 48-49 units. The Economics and Statistics major would then total 201-211 units.

Linear Algebra

One of the following three courses:

21-240 Matrix Algebra with Applications 10
21-241 Matrices and Linear Transformations 10
21-242 Matrix Theory 10

Note: 21-241 and 21-242 are intended only for students with a very strong mathematical background.

II. Foundations 18-36 units

2. Economics Foundations 18 units

73-102 Principles of Microeconomics 9
73-103 Principles of Macroeconomics 9

3. Statistical Foundations 9-18 units

Sequence 1 (For students beginning their freshman or sophomore year)

Beginning*

Choose one of the following courses:

36-200 Reasoning with Data 9
36/70-207 Probability and Statistics for Business* Applications 9
36-220 Engineering Statistics and Quality Control 9
36-247 Statistics for Lab Sciences 9

Note: Students who enter the program with 36-225 or 36-226 should discuss options with an advisor. Any 36-300 or 36-400 level course in Data Analysis that does not satisfy any other requirement for the Economics and Statistics Major may be counted as a Statistical Elective.

Intermediate*

Choose one of the following courses:

36-202 Methods for Statistics & Data Science ** 9
36-208 Regression Analysis 9

36-290 Introduction to Statistical Research Methodology 9
36-309 Experimental Design for Behavioral & Social Sciences 9

* Or extra data analysis course in Statistics
** Must take prior to 36-401 Modern Regression, if not, an additional Advanced Statistics Elective is required.

AdvancedStatistics Elective

Choose two of the following courses:

36-303 Sampling, Survey and Society 9
36-311 Statistical Analysis of Networks 9
36-313 Statistics of Inequality and Discrimination 9
36-315 Statistical Graphics and Visualization 9
36-461 Special Topics: Statistical Methods in Epidemiology 9
36-462 Special Topics: Methods of Statistical Learning 9
36-463 Special Topics: Multilevel and Hierarchical Models 9
36-464 Special Topics: Applied Multivariate Methods 9
36-465 Special Topics: Conceptual Foundations of Statistical Learning 9
36-466 Special Topics: Statistical Methods in Finance 9
36-467 Special Topics: Data over Space & Time 9
36-468 Special Topics: Text Analysis 9
36-469 Special Topics: Statistical Genomics and High Dimensional Inference 9
36-490 Undergraduate Research 9
36-493 Sports Analytics Capstone 9
36-497 Corporate Capstone Project 9

Sequence 2 (For students beginning later in their college career)

AdvancedStatistics Electives

Choose three of the following courses:

36-303 Sampling, Survey and Society 9
36-311 Statistical Analysis of Networks 9
36-313 Statistics of Inequality and Discrimination 9
36-315 Statistical Graphics and Visualization 9
36-461 Special Topics: Statistical Methods in Epidemiology 9
36-462 Special Topics: Methods of Statistical Learning 9
36-463 Special Topics: Multilevel and Hierarchical Models 9
36-464 Special Topics: Applied Multivariate Methods 9
36-465 Special Topics: Conceptual Foundations of Statistical Learning 9
36-466 Special Topics: Statistical Methods in Finance 9
36-467 Special Topics: Data over Space & Time 9
36-468 Special Topics: Text Analysis 9
36-469 Special Topics: Statistical Genomics and High Dimensional Inference 9
36-490 Undergraduate Research 9
36-493 Sports Analytics Capstone 9
36-497 Corporate Capstone Project 9

** All Special Topics are not offered every semester, and new Special Topics are regularly added. See section 5 for details.

III. Disciplinary Core 126 units

1. Economics Core 45 units

73-230 Intermediate Microeconomics 9
73-240 Intermediate Macroeconomics 9
73-270 Professional Communication for Economists 9
73-265 Economics and Data Science 9
73-274 Econometrics I 9
73-374 Econometrics II 9

2. Statistics Core 36 units

36-225 Introduction to Probability Theory ** 9
36-226 Introduction to Statistical Inference 9
or 36-326 Mathematical Statistics (Honors)
36-401 Modern Regression 9
36-402 Advanced Methods for Data Analysis 9

*In order meet the prerequisite requirements for the major, a grade of C or better is required in 36-225 (or equivalents), 36-226 or 36-326 and 36-401.

#It is possible to substitute 36-218, 36-219 or 21-325 for 36-225. 36-225 is the standard introduction to probability, 36-219 is tailored for engineers and computer scientists, 36-218 is a more mathematically rigorous class for Computer Science students and more mathematically advanced Statistics students (Statistics students need advisor approval to enroll), and 21-325 is a rigorous Probability Theory course offered by the Department of Mathematics.

3. Statistical Computing 9 units
36-350 Statistical Computing 9

4. Advanced Electives 36 units

Students must take two advanced Economics elective courses (numbered 73-300 through 73-495, excluding 73-374) and two (or three - depending on previous coursework, see Section 3) advanced Statistics elective courses (numbered 36-303, 36-311, 36-313, 36-315, 36-405, 36-490, 36-493 or 36-497).

Students pursuing a degree in Economics and Statistics also have the option of earning a concentration area (https://www.cmu.edu/tepper/programs/undergraduate-economics/curriculum/concentrations/) in Economics by completing a set of interconnected electives. While a concentration area is not required for this degree, it is an additional option that allows students to explore a group of aligned topics and/or develop a specialized and advanced skill set appropriate for a desired career path. The electives required for this degree may count towards your concentration area. To fulfill a concentration, students must take four courses from the designated set of electives. Please make sure to consult an advisor when choosing these courses.

Total number of units for the major 191-201 units
Total number of units for the degree 360 units

Professional Development

While not required, students are strongly encouraged to take advantage of professional development opportunities and/or coursework. One option is 73-210 Economics Colloquium I, a fall-only course that provides information about careers in Economics, job search strategies, and research opportunities. The Department of Statistics and Data Science also offers a series of workshops pertaining to resume preparation, graduate school applications, careers in the field, among other topics. Students should also take advantage of the Career and Professional Development Center.

Additional Major in Economics and Statistics

Students who elect Economics and Statistics as an additional major must fulfill all Economics and Statistics degree requirements. Majors in many other programs would naturally complement an Economics and Statistics Major, including Tepper’s undergraduate business program, Social and Decision Sciences, Policy and Management, and Psychology.

With respect to double-counting courses, it is departmental policy that students must have at least six courses [three Economics (73-xxx) and three Statistics (36-xxx)] that do not count for their primary major. If students do not have at least three ECON and three STA classes, they will need to take additional advanced data analysis or economics electives, depending on where the double-counting issue is.

Students are advised to begin planning their curriculum (with appropriate advisors) as soon as possible. This is particularly true if the other major has a complex set of requirements and prerequisites or when many of the other major’s requirements overlap with the requirements for a Major in Economics and Statistics.

Many departments require Statistics courses as part of their Major or Minor programs. Students seeking transfer credit for those requirements from substitute courses (at Carnegie Mellon or elsewhere) should seek permission from their advisor in the department setting the requirement. The final authority in such decisions rests there. The Department of Statistics and Data Science does not provide approval or permission for substitution or waiver of another department’s requirements.

If a waiver or substitution is made in the home department, it is not automatically approved in the Department of Statistics and Data Science.

In many of these cases, the student will need to take additional courses to satisfy the Economics and Statistics major requirements. Students should discuss this with a Statistics advisor when deciding whether to add an additional major in Economics and Statistics.

Sample Program

The following sample program illustrates one way to satisfy the requirements of the Economics and Statistics Major. Keep in mind that the program is flexible and can support other possible schedules (see footnotes below the schedule).

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Sophomore</th>
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<tbody>
<tr>
<td>Fall</td>
<td>Spring</td>
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<tr>
<td>21-120 Differential and Integral Calculus</td>
<td>36-202 Methods for Data Analysis</td>
</tr>
<tr>
<td>36-200 Reasoning with Data</td>
<td>21-256 Multivariate Analysis</td>
</tr>
<tr>
<td>73-102 Principles of Microeconomics</td>
<td>73-103 Principles of Macroeconomics</td>
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<tr>
<td>73-050 Economics: BaseCamp *not required</td>
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*In each semester, ----- represents other courses (not related to the major) which are needed in order to complete the 360 units that the degree requires.

Prospective PhD students are advised to add 21-127 fall of sophomore year, replace 21-240 with 21-241, add 21-260 in spring of junior year and 21-355 in fall of senior year.

Minor in Economics

In addition to preparing students to be better informed global citizens and consumers, the Minor in Economics provides students with the economic and data analytical toolkit that is the foundation of business/organizational decision-making.

All university students are eligible to pursue the Minor in Economics in conjunction with a major in any other department in the university. In order to avoid “double counting” issues, students are encouraged to meet with an economics advisor. When courses are shared across degrees, students pursuing a minor in Economics are asked to take additional advanced economics electives.

All economics courses counting towards the minor must be completed with a grade of “C” or higher.

**Minor in Economics (Total Number of Units for the Minor: 82)**

Mathematics Requirements (10 Units)

<table>
<thead>
<tr>
<th>Units</th>
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<tbody>
<tr>
<td>21-120 Differential and Integral Calculus</td>
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<td>21-256 Multivariate Analysis</td>
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<tr>
<td>or 21-259 Calculus in Three Dimensions</td>
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<tr>
<td>or 21-268 Multidimensional Calculus</td>
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<td>or 21-269 Vector Analysis</td>
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Economic Theory Requirements (27 Units)

<table>
<thead>
<tr>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>73-102 Principles of Microeconomics</td>
</tr>
<tr>
<td>73-103 Principles of Macroeconomics</td>
</tr>
</tbody>
</table>
73-230 Intermediate Microeconomics 9
or 73-240 Intermediate Macroeconomics

Please note that 21-256 (or it's equivalents) is a pre-requisite for 73-230 and 73-240.

Quantitative Analysis Requirements (18 Units)
The quantitative analysis path is often determined by the major requirements. The sequence is designed to give students an understanding of probability theory, regression analysis, and quantitative economic analysis. Students are encouraged to talk with an economics advisor to determine which requirements best complement their primary fields of study. Students who have taken coursework in intermediate-level regression analysis and data visualization may petition to substitute 73-274 Econometrics I or 73-423 Forecasting for Economics and Business for 73-265 Economics and Data Science. Please talk with an economics advisor to discuss your quantitative coursework.

36-200 Reasoning with Data Units
or 15-259 Probability and Computing
or 21-325 Probability
or 36-207 Probability and Statistics for Business Applications
or 36-218 Probability Theory for Computer Scientists
or 36-219 Probability Theory and Random Processes
or 36-220 Engineering Statistics and Quality Control
or 36-225 Introduction to Probability Theory
or 36-247 Statistics for Lab Sciences
or 70-207 Probability and Statistics for Business Applications

Advanced Economics Electives (27 Units)
Students must take three advanced elective courses. Advanced elective courses are those numbered 73-3xx through 73-49x. Students are encouraged to work with their economics advisor to structure a set of courses to meet these requirements based on their particular interests, subject to course availability.

Faculty

LAURENCE ALES, Associate Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2008–
SERRA BORANBAY AKAN, Assistant Teaching Professor of Economics – Ph.D., Northwestern University; Carnegie Mellon, 2013–
JAMES A. BEST, Assistant Professor of Economics – Ph.D., University of Edinburgh; Carnegie Mellon, 2018–
DAVID CHILDE RS, Assistant Professor of Economics – Ph.D., Yale University; Carnegie Mellon, 2016–
KAREN B. CLAY, Professor of Economics and Public Policy, H. J. Heinz III College – Ph.D., Stanford University; Carnegie Mellon, 1998–
ROBERT M. DAMMON, Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1984–
KENNETH B. DUNN, Professor of Financial Economics – Ph.D., University of Wisconsin; Carnegie Mellon, 1984–
DENNIS N. EPPEL, Thomas Lord University Professor of Economics – Ph.D., Princeton University; Carnegie Mellon, 1974–
SELMAN EROL, Assistant Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 2016–
CHRISTINA FONG, Senior Research Scientist in Social and Decision Sciences, Dietrich College of Humanities and Social Sciences – Ph.D., University of Massachusetts; Carnegie Mellon, 2001–
JOHN GASPER, Associate Teaching Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2010–
MARTIN GAYNOR, E.J. Barone University Professor of Economics and Health Policy, H. J. Heinz III College – Ph.D., Northwestern University; Carnegie Mellon, 1995–
BURTON HOLLIFIELD, Head, B.S. in Business Administration Program; PNC Professor of Finance; Professor of Financial Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 1999–

KARAM KANG, Associate Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 2012–
ALEXEY KUSHNIR, Associate Professor of Economics - Ph.D., Pennsylvania State University; Carnegie Mellon, 2014–
REBECCA LESSEM, Associate Professor of Economics - Ph.D., University of Wisconsin-Madison; Carnegie Mellon, 2011–
BENNETT T. MCCALLUM, H. J. Heinz Professor of Economics, Emeritus – Ph.D., Rice University; Carnegie Mellon, 1981–
NICHOLAS MULLER, Professor of Economics, Engineering, and Public Policy – Ph.D., Yale University; Carnegie Mellon, 2017–
ANH NGUYEN, Assistant Professor of Economics – Ph.D., Columbia University; Carnegie Mellon, 2018–
JOHN R. O’BRIEN, Associate Dean, Carnegie Mellon University-Qatar; Associate Professor of Accounting and Experimental Economics – Ph.D., University of Minnesota; Carnegie Mellon, 1984–
MARYAM SAEDI, Assistant Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2016–
ALI SHOURIDEH, Associate Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2016–
CHRISTOPHER SLEET, H.J. Heinz Professor of Economics – Ph.D., Stanford University; Carnegie Mellon, 2005–
FALLAW B. SOWELL, Associate Professor of Economics – Ph.D., Duke University; Carnegie Mellon, 1988–
CHESTER S. SPATT, Pamela R. and Kenneth B. Dunn Professor of Finance – Ph.D., University of Pennsylvania; Carnegie Mellon, 1979–
STEPHEN E. SPEAR, Professor of Economics – Ph.D., University of Pennsylvania; Carnegie Mellon, 1982–
CHRISTOPHER I. TELMER, Head, Economics Programs; Associate Professor of Financial Economics – Ph.D., Queen’s University (Canada); Carnegie Mellon, 1992–
ARIEL ZETLIN-JONES, Associate Professor of Economics – Ph.D., University of Minnesota; Carnegie Mellon, 2012–

Adjunct Faculty

CAROL B. GOLDBURG, Executive Director, Undergraduate Economics Program; Adjunct Professor of Economics – Ph.D., Carnegie Mellon University; Carnegie Mellon, 2005–
MARGARITA PORTNYKH, Adjunct Professor of Economics – Ph.D., Clemson University; Carnegie Mellon, 2018–

Undergraduate Economics Program