The Quantitative/Formal Reasoning (QFR) requirement is intended to help students become adept at reasoning mathematically and abstractly. The ability to apply a formal method to reach conclusions, use numbers comfortably, and employ the research tools necessary to analyze data lessens barriers to carrying out professional and economic roles. The hallmarks of a QFR course are the representation of facts in a language of mathematical symbols and the use of formal rules to obtain a determinate answer. Primary evaluation in these courses is based on multistep mathematical, statistical, or logical inference (as opposed to descriptive answers).

Prior to senior year, all students must satisfactorily complete ONE QFR course. Students requiring extra assistance (as assessed during First Days) are normally placed into Mathematics 100/101/102, which is to be taken before fulfilling the QFR requirement.

**AMST 150  (F)  Data for Justice  (DPE) (QFR)**

**Cross-listings:** STS 150 / SOC 150 / WGSS 150 / INTR 150

**Secondary Cross-listing**

This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

**Class Format:** This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

**Requirements/Evaluation:** Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

**Prerequisites:** None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

**Enrollment Limit:** 18

**Enrollment Preferences:** Students without prior college-level courses in statistics and programming.

**Expected Class Size:** 18

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

**Difference, Power, and Equity Notes:** This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

**Quantitative/Formal Reasoning Notes:** This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024

LEC Section: 01    TR 9:55 am - 11:10 am    Chad M. Topaz

LEC Section: 02    TR 11:20 am - 12:35 pm    Chad M. Topaz

**AMST 363  (S)  Data for Justice Research Practicum  (DPE) (QFR)**
Cross-listings: WGSS 363 / STS 363 / INTR 350

Secondary Cross-listing

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10

Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor's preregistration survey (contact the instructor for link).

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

Difference, Power, and Equity Notes: Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

Quantitative/Formal Reasoning Notes: Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz

SEM Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz

ASTR 111 (F) Introduction to Astrophysics (QFR)

The science of astronomy spans vast scales of space and time, from individual atoms to entire galaxies and from the universe's beginning to the future fate of our Sun. In this course, we will survey some of the main ideas in modern astrophysics, with an emphasis on the physics of stars and galaxies. ASTR 111 is the first course in the Astrophysics and Astronomy major sequences. It is also appropriate for students planning to major in one of the other sciences or mathematics and for others who would like a quantitative introduction that emphasizes the relationship of contemporary physics to astronomy. Topics include gravity and orbits, radiation laws and stellar spectra, physical characteristics of the Sun and other stars, star formation and evolution, black holes, galaxies, the expanding universe, and the Big Bang. Students will also use telescopes to observe stars, nebulae, planets, and galaxies and to make daytime observations of the Sun.

Class Format: The class has weekly afternoon laboratory sessions, which will alternate between 'hands-on' activities and problem-solving/discussion sessions. Nighttime observing sessions will occur throughout the semester.

Requirements/Evaluation: weekly problem sets, two hour-long tests, a final exam, lab reports, and an observing portfolio

Prerequisites: a year of high school Physics, concurrent college Physics, or permission of instructor, and MATH 140 or equivalent

Enrollment Limit: 28; 14/lab

Enrollment Preferences: potential Astronomy majors

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course requires regular problem sets and quantitative assignments. The course will emphasize how physical equations explain the observed properties of the universe.

Fall 2024

LEC Section: 01    TR 11:20 am - 12:35 pm    Anne Jaskot
LAB Section: 02    M 1:10 pm - 3:50 pm    Kevin Flaherty, Anne Jaskot
LAB Section: 03    R 1:10 pm - 3:50 pm    Kevin Flaherty, Anne Jaskot

ASTR 206 (S) Astrobiology (QFR)
This course will focus on the development of complex life and its observational signatures, both on Earth and on other worlds. We will first investigate the conditions that have led to the development of complex life on Earth. We will view Earth over time from an outsider’s perspective and challenge preconceptions about the basic requirements for life. We will also explore the ‘hot spots’ in the search for life beyond Earth in our Solar System. Observations in the next decade may reveal biosignatures in the atmospheres of exoplanets. We will learn about these future observations, while also interacting with current research-grade data for other planets and learning about the methods used to constrain the physical conditions on other worlds. Using quantitative models, we will test the stability of Earth-like planets to the variable and potentially hostile conditions of evolving solar systems.

Requirements/Evaluation: weekly problem sets, one paper, two mid-term exams, and a final exam
Prerequisites: Math 130 and at least one prior physical science course (either Astronomy, Physics, Geosciences, or Chemistry), or permission of instructor
Enrollment Limit: 20
Enrollment Preferences: Science majors, with preference given to students majoring in Astronomy, Astrophysics, or Geosciences
Expected Class Size: 12
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: In this course students will make quantitative comparisons between environmental conditions on Earth, other planetary bodies, and models. The students will also examine observations regarding the detection and characterization of planetary bodies, including contemporary data.

Spring 2025

LEC Section: 01    MR 2:35 pm - 3:50 pm    Jason E. Young

ASTR 402 (S) Between the Stars: The Interstellar Medium (QFR)
The matter between the stars—the interstellar medium—tells the story of the evolution of galaxies and the stars within them. Stars are accompanied by diffuse matter all through their lifetimes, from their birthplaces in dense molecular clouds, to the stellar winds they eject as they evolve, and to their final fates as they shed their outer layers, whether as planetary nebulae or dazzling supernovae. As these processes go on, they enrich the interstellar medium with the products of the stars’ nuclear fusion. Interpreting the emission from this interstellar gas is one of astronomers’ most powerful tools to measure the physical conditions, motions, and composition of our own galaxy and others. In this course we will study the interstellar medium in its various forms, from cold, dense, star-forming molecular clouds to X-ray-emitting bubbles formed by supernovae. We will learn about the physical mechanisms that produce the radiation we observe, including radiative ionization and recombination, collisional excitation of "forbidden" lines, collisional ionization, and synchrotron radiation. Applying our understanding of these processes, we will analyze the physical conditions and chemical compositions of a variety of nebulae. Finally, we will discuss the evolution of interstellar material in galaxies across cosmic time. This course is observing-intensive. Throughout the semester, students will work in small groups to design, carry out, analyze, and critique their own observations of the interstellar medium taken using the rooftop telescope.

Class Format: Tutorial meetings will be scheduled with the professor. Students will also complete observing projects using the rooftop telescope.
Requirements/Evaluation: weekly problem sets, 10-page final paper, and observing projects
Prerequisites: ASTR 111 and PHYS 201 or permission of instructor
Enrollment Limit: 10
Enrollment Preferences: juniors and seniors
Expected Class Size: 6
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: In this course, students will derive quantitative physical formulas, use these equations to calculate and compare physical properties, and generate and analyze graphical representations of data. They will also make and analyze measurements of astronomical data through observing projects.

Spring 2025
TUT Section: T1 TBA Anne Jaskot

ASTR 413 (F) Building Stars: A Physical Model of Stellar Structure (QFR)
How does the Sun shine? How does the Sun evolve with time? What physical processes determine the power output of the Sun? In this course we will explore our modern understanding of how stars work, and why they have a range of sizes, temperatures, and luminosities. As we go, we will discuss the laws of physics at work in our Sun and other stars. Over the course of the semester, we will build a working computer model of the Sun using the basic laws of nuclear fusion, radiative transfer, thermal mechanics, and hydrostatic equilibrium.

Class Format: Lectures will include time for computer programming work
Requirements/Evaluation: weekly problem sets, weekly coding homework assignments, two mid-term exams, and a final project
Prerequisites: PHYS 142 or 151, any prior class that makes use of programming, or permission of instructor
Enrollment Limit: 10
Enrollment Preferences: Astronomy, Astrophysics, or Physics majors, with first preference to Astronomy or Astrophysics majors
Expected Class Size: 6
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: In this course, students will use differential equations and numerical coding techniques to test and explore the relationships between physical laws using the Sun and other stars as examples. They will make quantitative comparisons between their calculations and observed stellar properties.

Fall 2024
LEC Section: 01 TR 11:20 am - 12:35 pm Jason E. Young

ASTR 498 (S) Independent Study: Astronomy or Astrophysics (QFR)
Astronomy/Astrophysics independent study, directed by one of the Astronomy faculty: Pasachoff/Jaskot/Flaherty
Requirements/Evaluation: Regular work with the instructor; submitted presentations and papers as agreed upon
Prerequisites: suitable Astronomy/Astrophysics/Physics/Math-Stats-Geosciences/Chemistry courses
Enrollment Limit: 10
Enrollment Preferences: research topic
Expected Class Size: 5
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: Substantial quantitative and formal reasoning are involved

Spring 2025
IND Section: 01 TBA David R. Tucker-Smith
BIMO 321  (F)  Biochemistry I: Structure and Function of Biological Molecules  (QFR)

Cross-listings:  BIOL 321 / CHEM 321

Primary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

Enrollment Limit: 12/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 36

Grading:  no pass/fail option,  no fifth course option

Unit Notes: Cannot be counted towards the Biology major in addition to BIOL 222

Distributions:  (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 321(D3)  BIMO 321(D3)  CHEM 321(D3)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes:  BIGP Courses  BIMO Required Courses

Fall 2024

LEC Section: 01  MWF 10:00 am - 10:50 am  B Thuronyi
LAB Section: 02  T 1:00 pm - 5:00 pm
LAB Section: 03  W 1:00 pm - 5:00 pm
LAB Section: 04  R 1:00 pm - 5:00 pm

BIMO 322  (S)  Biochemistry II: Metabolism  (QFR)

Cross-listings:  CHEM 322 / BIOL 322

Primary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory three hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

Prerequisites:  BIOL 101, plus either: CHEM 156 and CHEM 256, or CHEM 155 and CHEM 156, or CHEM 200 and CHEM 201, or permission of instructor
Enrollment Limit: 48

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIMO 322(D3) CHEM 322(D3) BIOL 322(D3)

Quantitative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses BIMO Required Courses

Spring 2025

LEC Section: 01 TR 11:20 am - 12:35 pm Caitlyn E. Bowman-Cornelius

LAB Section: 02 M 1:00 pm - 3:50 pm Caitlyn E. Bowman-Cornelius

LAB Section: 03 W 1:00 pm - 3:50 pm Caitlyn E. Bowman-Cornelius

LAB Section: 04 R 1:00 pm - 3:50 pm Caitlyn E. Bowman-Cornelius

BIOLOG 202 (F) Genetics (QFR)

Genetics, classically defined as the study of heredity, is today a multidisciplinary field whose principles provide critical insight and tools to most areas of biology and medicine. This course covers the experimental basis for our current understanding of the inheritance, structures, and functions of genes. It introduces approaches used by contemporary geneticists and molecular biologists to explore questions in areas of biology ranging from evolution to medicine. A primary focus of the course is on students developing familiarity with problem solving, the logic and quantitative reasoning required to understand how genetic mechanisms lead to biological patterns. The laboratory part of the course provides an experimental introduction to modern genetic analysis as well as introductions to interpreting genetic reasoning in the primary research literature. Laboratory experiments include investigating chromosome structure using microscopy, mapping a mutation to the genome by integrating multiple streams of evidence, and determining the structure of a DNA plasmid using molecular tools.

Class Format: Lecture: three hours per week, Lab: three hours per week.

Requirements/Evaluation: bi-weekly problem sets; weekly laboratory exercises and laboratory reports; three exams

Prerequisites: BIOL 101 and 102

Enrollment Limit: 120

Enrollment Preferences: students interested in the Biology major

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course develops quantitative skills through solving problems. Students learn to apply basic calculations and logic to predict the outcomes of biological systems, for example, describing the likelihood that an individual will be affected by an inherited disease. Application of quantitative and logical analysis contributes to a large component of the in-class work and the graded material for the class, in the form of problem sets, exams, and data analysis for lab reports.

Attributes: BIGP Courses BIMO Required Courses

Fall 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Luana S. Maroja

LAB Section: 02 M 1:00 pm - 3:50 pm Derek Dean

LAB Section: 03 T 1:00 pm - 3:50 pm Derek Dean

LAB Section: 04 W 1:00 pm - 3:50 pm Derek Dean
BIOL 203  (F) Ecology  (QFR)

Cross-listings: ENVI 203

Primary Cross-listing

This course combines lectures & discussion with field and indoor laboratory activities to explore factors that determine the distribution and abundance of plants and animals in natural systems. The course begins with an overview of global environmental patterns and then builds from the population to ecosystem level. Throughout the course, we will emphasize the connection between basic ecological principles and current environmental issues. Selected topics include population dynamics (competition, predation, mutualism); community interactions (succession, food chains and diversity) and ecosystem function (biogeochemical cycles, energy flow). Laboratory activities are designed to engage students in the natural history of the region and build skills in data analysis and scientific writing.

Requirements/Evaluation: pre-class quizzes, lab reports, two mid-term exams, and a final exam

Prerequisites: BIOL 102, or ENVI 102, or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: students planning to pursue Biology and/or ENVI

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIOL 203(D3) ENVI 203(D3)

Quantitative/Formal Reasoning Notes: Much of the material in this course centers on the interpretation and application of mathematical models used to describe ecological systems. The laboratory section of this course also contains a large data analysis component (based in R). Students are introduced to linear models, multidimensional data analysis and contingency tables.

Attributes: ENVI Natural World Electives  EVST Environmental Science

Fall 2024

LEC Section: 01  TR 8:30 am - 9:45 am  Manuel A. Morales
LAB Section: 02  T 1:00 pm - 3:50 pm  Manuel A. Morales
LAB Section: 03  W 1:00 pm - 3:50 pm  Manuel A. Morales

BIOL 305  (S) Evolution  (QFR)

This course offers a critical analysis of contemporary concepts in biological evolution. We focus on the relation of evolutionary mechanisms (e.g., selection, drift, and migration) to long term evolutionary patterns (e.g., evolutionary innovations, origin of major groups, and adaptation). Topics include micro-evolutionary models, natural and sexual selection, speciation, the inference of evolutionary history, evolutionary medicine among others.

Requirements/Evaluation: independent research project, problem sets, participation in discussions and exams

Prerequisites: BIOL 102 and one 200 level BIOL course

Enrollment Limit: 24

Enrollment Preferences: Seniors and biology majors

Expected Class Size: 24

Grading: yes pass/fail option, yes fifth course option

Unit Notes: satisfies the distribution requirement for the Biology major

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: We will use mathematical models to study population genetics.

Attributes: BIGP Courses  BIMO Interdepartmental Electives  COGS Related Courses

Spring 2025
BIOL 321  (F)  Biochemistry I: Structure and Function of Biological Molecules  (QFR)

Cross-listings:  BIMO 321 / CHEM 321

Secondary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites:  BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

Enrollment Limit: 12/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 36

Grading:  no pass/fail option, no fifth course option

Unit Notes:  Cannot be counted towards the Biology major in addition to BIOL 222

Distributions:  (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIOL 321(D3) BIMO 321(D3) CHEM 321(D3)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes:  BIGP Courses  BIMO Required Courses

Fall 2024

LEC Section: 01  MWF 10:00 am - 10:50 am  B Thuronyi
LAB Section: 02  T 1:00 pm - 5:00 pm
LAB Section: 03  W 1:00 pm - 5:00 pm
LAB Section: 04  R 1:00 pm - 5:00 pm

BIOL 322  (S)  Biochemistry II: Metabolism  (QFR)

Cross-listings:  BIMO 322 / CHEM 322

Secondary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory three hours per week.
**Requirements/Evaluation:** several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

**Prerequisites:** BIOL 101, plus either: CHEM 156 and CHEM 256, or CHEM 155 and CHEM 156, or CHEM 200 and CHEM 201, or permission of instructor

**Enrollment Limit:** 48

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:** 48

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** cannot be counted towards the Biology major in addition to BIOL 222

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIMO 322(D3) CHEM 322(D3) BIOL 322(D3)

**Quantitative/Formal Reasoning Notes:** The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

**Attributes:** BIGP Courses  BIMO Required Courses

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**Spring 2025**

**LEC Section: 01**  TR 11:20 am - 12:35 pm  Caitlyn E. Bowman-Cornelius

**LAB Section: 02**  M 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius

**LAB Section: 03**  W 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius

**LAB Section: 04**  R 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius

**BIOL 420  (S) Mathematical Biology  (QFR)**

**Cross-listings:** MATH 412

**Secondary Cross-listing**

This course will provide an introduction to the many ways in which mathematics can be used to understand, analyze, and predict biological dynamics. We will learn how to construct mathematical models that capture essential properties of biological processes while maintaining analytic tractability. Analytic techniques, such as stability and bifurcation analysis, will be introduced in the context of both continuous and discrete time models. Additionally, students will couple these analytic tools with numerical simulation to gain a more global picture of the biological dynamics. Possible biological applications may include, but are not limited to, single and multi-species population dynamics, neural and biological oscillators, tumor cell growth, and infectious disease dynamics.

**Requirements/Evaluation:** problem sets, quizzes/exams, participation, final project and paper

**Prerequisites:** MATH 250 and MATH 309, or permission of instructor

**Enrollment Limit:** 30

**Enrollment Preferences:** preference for senior math/stats major and also based on an interest statement

**Expected Class Size:** 30

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 412(D3) BIOL 420(D3)

**Quantitative/Formal Reasoning Notes:** The course will introduce methods for developing and analyzing mathematical models.

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**Spring 2025**

**LEC Section: 01**  TR 9:55 am - 11:10 am  Julie C. Blackwood
CAOS 213 (S) Introduction to Environmental and Natural Resource Economics  (QFR)

Cross-listings: ECON 213 / ENVI 213

Secondary Cross-listing

We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

Requirements/Evaluation: problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)

Prerequisites: ECON 110 or equivalent

Enrollment Limit: 30

Enrollment Preferences: first-year and sophomore students

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Unit Notes: this course will count toward both the Environmental Studies major and concentration

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ECON 213(D2) ENVI 213(D2) CAOS 213(D2)

Quantitative/Formal Reasoning Notes: We will use formal theory expressed in math and graphs, perform calculations, and consume statistical data.

Attributes: ENVI Environmental Policy  EVST Social Science/Policy  POEC Depth

Spring 2025
LEC Section: 01    MWF 8:30 am - 9:45 am    Sarah A. Jacobson

CAOS 327 (F) Coastal Processes and Geomorphology  (QFR)

Cross-listings: ENVI 327 / GEOS 327

Secondary Cross-listing

Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces--wind, waves, storms, and people--that shape the coastal zone, as well as the geologic formations--sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs--that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change. Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week

Requirements/Evaluation: lab reports, quizzes, and an independent research project

Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.
Enrollment Limit: 15
Enrollment Preferences: Geosciences majors
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: This course counts toward the GEOS Group B Electives - Sediments + Life.
Distributions: (D3) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 327(D3) GEOS 327(D3) CAOS 327(D3)
Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.
Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life

CAOS 477 (F) Economics of Environmental Behavior (QFR)
Cross-listings: ENVI 376 / ECON 477
Secondary Cross-listing
A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.
Class Format: Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities
Requirements/Evaluation: class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory
Prerequisites: ECON 251 and (ECON 255 or STAT 346)
Enrollment Limit: 19
Enrollment Preferences: senior Economics majors and junior Economics majors considering a thesis
Expected Class Size: 19
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
CAOS 477(D2) ENVI 376(D2) ECON 477(D2)
Quantitative/Formal Reasoning Notes: The research students will consume and produce in the class will be based on math-based theory and/or econometric-based empirical analysis.
Attributes: CAOS Senior Seminars ENVI Humanities, Arts + Social Science Electives POEC Depth POEC Skills

CHEM 100 (F) Chemistry Matters (QFR)
Chemistry matters! From fueling the world's economy to preventing the next pandemic to forecasting future climate change, chemistry touches all aspects of daily life. This course provides an introduction to chemical principles and applications for students with little or no high school chemistry
background. Through the lens of contemporary issues and applications (e.g. energy, environment, materials, medicine, etc.), students will be introduced to concepts fundamental to studying matter at the molecular level. Particular emphasis will be placed on skills essential for students to understand chemistry in these contexts, including quantitative reasoning and the development of chemical literacy and intuition. Laboratory meetings will be used to reinforce lecture material through experimentation at the bench and active learning exercises.

Class Format: lecture, three times per week and laboratory, three hours per week

Requirements/Evaluation: problem set assignments, laboratory work and analysis, quizzes/exams and a final assessment

Prerequisites: Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement).

Enrollment Limit: 32; 16/lab

Enrollment Preferences: First-year students with little or no high school chemistry experience.

Expected Class Size: 32

Grading: yes pass/fail option, no fifth course option

Unit Notes: CHEM 100 may be taken concurrently with MATH 102—see under Mathematics; CHEM 100 or its equivalent is a prerequisite to CHEM 101.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets and in class activities in which quantitative/formal reasoning skills are practiced.

Fall 2024

LEC Section: 01    MWF 9:00 am - 9:50 am    Katie M. Hart
LAB Section: 02    W 1:00 pm - 4:00 pm
LAB Section: 03    R 1:00 pm - 4:00 pm

CHEM 101  (F)(S) Concepts of Chemistry  (QFR)

This course broadens and deepens the foundation in chemistry of students who have had one or more years of chemistry at the high school level. Most students begin study of chemistry at Williams with this course. Familiarity with stoichiometry, basic concepts of equilibria, the model of an atom, Lewis structures and VSEPR, and gas laws is expected. Principal topics for this course include modern atomic theory, molecular structure and bonding, states of matter, chemical equilibrium (acid-base and solubility), and an introduction to atomic and molecular spectroscopies. Laboratory periods will largely focus on experiment design, data analysis, literature, scientific writing, and other skills critical to students' development as scientists. The course is of interest to students who anticipate professional study in chemistry, related sciences, or one of the health professions, as well as to those who want to explore the fundamentals of chemistry as part of their general education. This course may be taken pass/fail; however, students who are considering graduate study in science or in the health professions should elect to take this course for a grade.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: problem sets and/or quizzes, laboratory work, and exams

Prerequisites: Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement) or CHEM 100.

Enrollment Limit: 45; 16/lab

Enrollment Preferences: first-year students

Expected Class Size: 45/lecture

Grading: yes pass/fail option, no fifth course option

Unit Notes: CHEM 101 or its equivalent is a prerequisite for both CHEM 200 and CHEM 201 and is required for the BIMO concentration.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

Fall 2024
CHEM 200 (S)  Advanced Chemical Concepts  (QFR)

This course treats an array of topics in modern chemistry, emphasizing broad concepts that connect and weave through the various subdisciplines of the field--biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. It provides the necessary background in chemical science for students who are planning advanced study or a career in chemistry, biological science, geoscience, environmental science, or a health profession. Topics include coordination complexes, thermodynamics, electrochemistry, and kinetics. Laboratory sections will give students hands-on experience involving synthesis, characterization, and reactivity studies of coordination and organic complexes; spectroscopic analyses; thermodynamics; electrochemistry; and kinetics. Students will hone their skills in the presentation of results through written reports and worksheets.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: homework assignments, laboratory work, quizzes, midterm exam, and a final exam

Prerequisites: CHEM 101

Enrollment Limit: 35; 16/lab

Enrollment Preferences: first-year students, then sophomores

Expected Class Size: 35

Grading: no pass/fail option, no fifth course option

Unit Notes: CHEM 200 is required for the BIMO concentration

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses
of structure and reactivity. Specific topics include basic organic structures and bonding, delocalization and conjugation, acidity & basicity, nucleophilic addition and substitution reactions, stereochemistry and molecular energetics. The theory and interpretation of infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy, as well as the fundamentals of molecular modeling as applied to organic molecules are presented. The coordinated laboratory work includes organic synthesis, purification and separation techniques, as well as characterization by IR and NMR spectroscopy.

**Class Format:** lecture, three times per week and laboratory, four hours per week

**Requirements/Evaluation:** quantitative problem solving, laboratory performance, three midterm exams, and a final exam

**Prerequisites:** CHEM 101 or CHEM 151, 153, or 155

**Enrollment Limit:** 40; 12/lab

**Enrollment Preferences:** Seniors, juniors, sophomores, first-year students

**Expected Class Size:** 40

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course fulfills the QFR requirement with regular and substantial problem solving in which quantitative/formal reasoning skills are practiced and evaluated.

**Attributes:** BIMO Required Courses

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Fall 2024

**LEC Section: 01** MWF 9:00 am - 9:50 am  Kerry-Ann Green

**LEC Section: 02** MWF 10:00 am - 10:50 am  Amanda K. Turek

**LAB Section: 03** M 1:00 pm - 5:00 pm

**LAB Section: 04** T 1:00 pm - 5:00 pm

**LAB Section: 05** W 1:00 pm - 5:00 pm

**LAB Section: 06** R 1:00 pm - 5:00 pm

**LAB Section: 07** M 1:00 pm - 5:00 pm

**LAB Section: 08** T 1:00 pm - 5:00 pm

**LAB Section: 09** W 1:00 pm - 5:00 pm

**LAB Section: 10** T 8:00 am - 12:00 pm

**CHEM 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)**

**Cross-listings:** BIOL 321 / BIMO 321

**Secondary Cross-listing**

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

**Class Format:** lecture, three times per week and laboratory, four hours per week

**Requirements/Evaluation:** quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

**Prerequisites:** BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

**Enrollment Limit:** 12/lab

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:** 36

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** Cannot be counted towards the Biology major in addition to BIOL 222
CHEM 322 (S) Biochemistry II: Metabolism (QFR)

Secondary Cross-listing
This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory three hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

Prerequisites: BIOL 101, plus either: CHEM 156 and CHEM 256, or CHEM 155 and CHEM 156, or CHEM 200 and CHEM 201, or permission of instructor

Enrollment Limit: 48

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIMO 322(D3) CHEM 322(D3) BIOL 322(D3)

Quantitative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses BIMO Required Courses
This course introduces quantum mechanics, which serves as the basis for understanding molecular structure and spectroscopy. We will begin by discussing the Schrödinger wave equation and then apply this to understanding the translational, vibrational, and rotational structure of molecules. This leads to a discussion of atomic/molecular electronic structure and spectroscopy. Computational methods will be taught to illustrate key quantum mechanical concepts, interpret experimental data, and extend hypotheses. Applications will be chosen from contemporary research fields, including photochemistry, laser spectroscopy, environmental/atmospheric chemistry, organometallic chemistry, and physical organic chemistry.

Requirements/Evaluation: class participation, problem sets, exams, and laboratory work

Prerequisites: CHEM 155 or CHEM 256; or CHEM 200; or permission of instructor; and strongly recommend MATH 150 or MATH 151

Enrollment Limit: 16; 8/lab

Enrollment Preferences: seniors, then juniors

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFC requirement and relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

Spring 2025

LEC Section: 01    MWF 11:00 am - 12:15 pm    Ben L. Augenbraun
LAB Section: 02    T 1:00 pm - 5:00 pm    Ben L. Augenbraun
LAB Section: 03    R 1:00 pm - 5:00 pm    Ben L. Augenbraun

CHEM 366 (F) Thermodynamics and Statistical Mechanics (QFR)
The thermodynamic laws provide us with our most powerful and general scientific principles for predicting the direction of spontaneous change in physical, chemical, and biological systems. This course develops the concepts of energy, entropy, free energy, temperature, heat, work, and chemical potential within the framework of classical and statistical thermodynamics. The principles developed are applied to a variety of problems: chemical reactions, phase changes, energy technology, industrial processes, and environmental science. Laboratory experiments provide quantitative and practical demonstrations of the theory of real and ideal systems studied in class.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: class participation, oral presentations, problem sets, laboratory work, and an independent project

Prerequisites: CHEM 155 or CHEM 256; or CHEM 200; and basic knowledge of applied integral and differential calculus

Enrollment Limit: 16/lab

Enrollment Preferences: Chemistry majors: seniors, juniors, then sophomores

Expected Class Size: 16

Grading: no pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFC requirement and relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

Attributes: BIMO Interdepartmental Electives

Fall 2024

LEC Section: 01    MWF 11:00 am - 12:15 pm    Enrique Peacock-López
LAB Section: 02    T 1:00 pm - 5:00 pm    Enrique Peacock-López

COGS 224 (F) Introduction to Formal Linguistics (QFR)

Cross-listings: PHIL 221

Primary Cross-listing
The sentence "Every cookie is chocolate chip and three of them are oatmeal raisin" is a perfectly grammatical sentence of English, but it's self-contradictory. What does it take to realize this fact? One must grasp the meanings of the various parts of the sentence. In particular, one must grasp that "three of them" picks out a subset of the group picked out by "every cookie", and that there's no such thing as a cookie that is both chocolate chip and oatmeal raisin. There two ways to understand "Many students took every class". According to one, there is a single group of students that had their hands extremely full this semester. According to the other, every class was well-populated, potentially by different groups. The reason for this is that there are two underlying structures that the original sentence can realize. This course serves as an introduction to formal methods in the scientific study of language. Our goal will be to characterize phenomena like those above with logical and mathematical precision. The focus will be on model-theoretic semantics, the sub-field of linguistics that studies meanings. Along the way we will discuss principles of syntax, the sub-field that studies sentence structures, and pragmatics, the sub-field that studies inferences of non-literal content. This is a formal course, but no prior logical or mathematical background will be expected. Starting from scratch, students will learn the building blocks of current-day linguistic research. This introduction will be of use to students interested in language from a variety of perspectives, including philosophy, cognitive science, and computer science.

**Requirements/Evaluation:** Weekly problem sets, plus a final project (paper/presentation/other type, to be discussed with instructor)

**Prerequisites:** No prerequisites

**Enrollment Limit:** 20

**Enrollment Preferences:** Preference given to seniors and philosophy/cognitive science majors.

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**

PHIL 221(D2) COGS 224(D2)

**Quantitative/Formal Reasoning Notes:** This course teaches the fundamentals of the formal analysis of language. Students will learn to provide translation schemes from English to a logical language (typed lambda calculus).

**Attributes:** COGS Interdepartmental Electives COGS Related Courses Linguistics PHIL Contemp Metaphysics + Epistemology Courses

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**CSCI 104 (F) Data Science and Computing for All (QFR)**

Many of the world's greatest discoveries and most consequential decisions are enabled or informed by the analysis of data from a myriad of sources. Indeed, the ability to wrangle, visualize, and draw conclusions from data is now a critical tool in the sciences, business, medicine, politics, other academic disciplines, and society as a whole. This course lays the foundations for quantifying relationships in data by exploring complementary computational, statistical, and visualization concepts. These concepts will be reinforced by lab experiences designed to teach programming and statistics skills while analyzing real-world data sets. This course will also examine the broader context and social issues surrounding data analysis, including privacy and ethics.

**Requirements/Evaluation:** Weekly lab assignments involving programming, a project, and examinations.

**Prerequisites:** None; previous programming experience or statistics is not required.

**Enrollment Limit:** 30;15/lab

**Enrollment Preferences:** Not open to those who have completed or are currently enrolled in a Computer Science course numbered 136 or higher. Preference given to those who have not previously taken a computer science or statistics course.

**Expected Class Size:** 30

**Grading:** yes pass/fail option, no fifth course option

**Unit Notes:** Additional details about the class are available here: https://www.cs.williams.edu/~cs104. Please see the Computer Science Department website for more information on selecting an introductory computer science class: https://csci.williams.edu/

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course includes regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.
CSCI 134  (F)(S) Introduction to Computer Science  (QFR)
This course introduces students to the science of computation by exploring the representation and manipulation of data and algorithms. We organize and transform information in order to solve problems using algorithms written in a modern object-oriented language. Topics include organization of data using objects and classes, and the description of processes using conditional control, iteration, methods and classes. We also begin the study of abstraction, self-reference, reuse, and performance analysis. While the choice of programming language and application area will vary in different offerings, the skills students develop will transfer equally well to more advanced study in many areas. In particular, this course is designed to provide the programming skills needed for further study in computer science and is expected to satisfy introductory programming requirements in other departments.

Requirements/Evaluation:  weekly programming projects, weekly written homeworks, and two examinations.
Prerequisites:  none, except for the standard prerequisites for a (QFR) course; previous programming experience is not required
Enrollment Limit:  30;15/lab
Enrollment Preferences:  if the course is over-enrolled, enrollment will be determined by lottery.
Expected Class Size:  30/lec
Grading:  yes pass/fail option,  yes fifth course option
Unit Notes:  Please see the Computer Science Department website for more information on selecting an introductory computer science class: https://csci.williams.edu/. Students with prior experience with object-oriented programming should discuss appropriate course placement with members of the department.
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  This course includes regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.
Attributes:  COGS Interdepartmental Electives
CSCI 136  (F)(S)  Data Structures and Advanced Programming  (QFR)
This course builds on the programming skills acquired in Computer Science 134. It couples work on program design, analysis, and verification with an introduction to the study of data structures. Data structures capture common ways in which to store and manipulate data, and they are important in the construction of sophisticated computer programs. Students are introduced to some of the most important and frequently used data structures: lists, stacks, queues, trees, hash tables, graphs, and files. Students will be expected to write several programs, ranging from very short programs to more elaborate systems. Emphasis will be placed on the development of clear, modular programs that are easy to read, debug, verify, analyze, and modify.

Requirements/Evaluation:  programming and written assignments, quizzes, examinations
Prerequisites:  CSCI 134 or equivalent; fulfilling the Discrete Mathematics Proficiency requirement is recommended, but not required
Enrollment Limit:  30;15/lab
Enrollment Preferences:  if the course is over-enrolled, enrollment will be determined by lottery.
Expected Class Size:  30/sec
Grading:  yes pass/fail option,  no fifth course option
Unit Notes:  Please see the Computer Science Department website for more information on selecting an introductory computer science class:  https://csci.williams.edu/
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This course include regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.
Attributes:  BIGP Courses

Fall 2024
LEC Section: 01  MWF 9:00 am - 9:50 am  James M. Bern
LEC Section: 02  MWF 10:00 am - 10:50 am  James M. Bern
LAB Section: 03  W 1:00 pm - 2:30 pm  James M. Bern
LAB Section: 04  W 2:30 pm - 4:00 pm  James M. Bern
LAB Section: 05  R 1:00 pm - 2:30 pm  James M. Bern
LAB Section: 06  R 2:30 pm - 4:00 pm  James M. Bern

Spring 2025
LEC Section: 01  MWF 9:00 am - 9:50 am  Katie A. Keith
LEC Section: 02  MWF 10:00 am - 10:50 am  Katie A. Keith
LAB Section: 03  W 1:00 pm - 2:30 pm  Katie A. Keith
LAB Section: 04  W 2:30 pm - 4:00 pm  Katie A. Keith
LAB Section: 05  R 1:00 pm - 2:30 pm  Katie A. Keith
LAB Section: 06  R 2:30 pm - 4:00 pm  Katie A. Keith

CSCI 237  (F)(S)  Computer Organization  (QFR)
This course studies the basic instruction set architecture and organization of a modern computer. It provides a programmer's view of how computer systems execute programs, store information, and communicate. Over the semester the student learns the fundamentals of translating higher level languages into assembly language, and the interpretation of machine languages by hardware. At the same time, a model of computer hardware organization is developed from the gate level upward.
Requirements/Evaluation: weekly programming assignments and/or problem sets, quizzes, midterm and final exams
Prerequisites: CSCI 136
Enrollment Limit: 24;12/lab
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024
LEC Section: 01 MWF 10:00 am - 10:50 am Kelly A. Shaw
LEC Section: 02 MWF 11:00 am - 11:50 am Kelly A. Shaw
LAB Section: 03 W 1:00 pm - 2:30 pm Kelly A. Shaw
LAB Section: 04 W 2:30 pm - 4:00 pm Kelly A. Shaw
LAB Section: 05 R 1:00 pm - 2:30 pm Kelly A. Shaw
LAB Section: 06 R 2:30 pm - 4:00 pm Kelly A. Shaw

Spring 2025
LEC Section: 01 MWF 11:00 am - 11:50 am Jeannie R Albrecht
LAB Section: 02 W 1:00 pm - 2:30 pm Jeannie R Albrecht
LAB Section: 03 R 1:00 pm - 2:30 pm Jeannie R Albrecht

CSCI 256 (F)(S) Algorithm Design and Analysis (QFR)
This course investigates methods for designing efficient and reliable algorithms. By carefully analyzing the structure of a problem within a mathematical framework, it is often possible to dramatically decrease the computational resources needed to find a solution. In addition, analysis provides a method for verifying the correctness of an algorithm and accurately estimating its running time and space requirements. We will study several algorithm design strategies that build on data structures and programming techniques introduced in Computer Science 136. These include greedy, divide-and-conquer, dynamic programming, and network flow algorithms. Additional topics of study include algorithms on graphs and strategies for handling potentially intractable problems.

Requirements/Evaluation: Problem sets, midterm and final examinations
Prerequisites: CSCI 136 and fulfillment of the Discrete Mathematics Proficiency requirement
Enrollment Limit: 24
Enrollment Preferences: Preference will be given to students who need the class in order to complete the major. Ties will be broken by seniority (seniors first, then juniors, etc.).
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course will have weekly problem sets in which students will formally prove statements about the behavior and performance of algorithms. In short, the course is about applying abstract and mathematical reasoning to the study of algorithms and computation.

Fall 2024
LEC Section: 01 MWF 12:00 pm - 12:50 pm Aaron M. Williams

Spring 2025
LEC Section: 01 MR 1:10 pm - 2:25 pm Samuel McCauley
LEC Section: 02 MR 2:35 pm - 3:50 pm Samuel McCauley
CSCI 315  (F)  Computational Biology  (QFR)

Cross-listings: PHYS 315

Secondary Cross-listing

This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and statistics.

Requirements/Evaluation: weekly Python programming assignments, code reviews, problem sets, plus a few quizzes and a final project

Prerequisites: programming experience (e.g., CSCI 136) and mathematics (PHYS/MATH 210 or MATH 150) and physical science (PHYS 142/151, or CHEM 101/15X), or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: if over-enrolled, a questionnaire will be circulated

Expected Class Size: 8

Grading: no pass/fail option, no fifth course option

Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
CSCI 315(D3) PHYS 315(D3)

Quantitative/Formal Reasoning Notes: problem sets and programming assignments

Attributes: BIGP Courses

Fall 2024
LEC Section: 01  MR 2:35 pm - 3:50 pm  Daniel P. Aalberts

CSCI 334  (S)  Principles of Programming Languages  (QFR)

This course examines the concepts and structures governing the design and implementation of programming languages. It presents an introduction to the concepts behind compilers and run-time representations of programming languages; features of programming languages supporting abstraction and polymorphism; and the procedural, functional, object-oriented, and concurrent programming paradigms. Programs will be required in languages illustrating each of these paradigms.

Requirements/Evaluation: weekly problem sets and programming assignments, a midterm examination, and a final examination

Prerequisites: CSCI 136

Enrollment Limit: 30

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 30

Grading: yes pass/fail option, no fifth course option

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: This course include regular and substantial problem sets and labs in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025
LEC Section: 01  MR 1:10 pm - 2:25 pm  Daniel W. Barowy

LEC Section: 02  MR 2:35 pm - 3:50 pm  Daniel W. Barowy

CSCI 338  (S)  Parallel Processing  (QFR)

This course explores different parallel programming paradigms used for writing applications on today's parallel computer systems. The course will
introduce concurrency (i.e. multiple simultaneous computations) and the synchronization primitives that allow for the creation of correct concurrent applications. It will examine how a variety of systems organize parallel processing resources and enable users to write parallel programs for these systems. Covered programming paradigms will include multiprogramming with processes, message passing, threading in shared memory multiprocessors, vector processing, graphics processor programming, transactions, MapReduce, and other forms of programming for the cloud. Class discussion is based on assigned readings. Assignments provide students the opportunity to develop proficiency in writing software using different parallel programming paradigms.

Requirements/Evaluation: homework assignments, programming projects, and up to two exams

Prerequisites: CSCI 136 or equivalent programming experience, and CSCI 237, or permission of instructor

Enrollment Limit: 24

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of substantial problem sets and programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025

LEC Section: 01  TR 9:55 am - 11:10 am  Kelly A. Shaw

CSCI 339  (F)  Distributed Systems  (QFR)

This course studies the key design principles of distributed systems, which are collections of independent networked computers that function as single coherent systems. Covered topics include communication protocols, processes and threads, naming, synchronization, consistency and replication, fault tolerance, and security. Students also examine some specific real-world distributed systems case studies, including Google and Amazon. Class discussion is based on readings from the textbook and research papers. The goals of this course are to understand how large-scale computational systems are built, and to provide students with the tools necessary to evaluate new technologies after the course ends.

Requirements/Evaluation: weekly homework assignments, midterm exam, 3 major programming projects, and a final project

Prerequisites: CSCI 237

Enrollment Limit: 24

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024

LEC Section: 01  MR 1:10 pm - 2:25 pm  Jeannie R Albrecht

CSCI 345  (S)  Robotics and Digital Fabrication  (QFR)

This course is a hands-on exploration of topics in robotics and digital fabrication. We will experience firsthand how ideas and methods from computer science can be applied to make physical objects, including robots and other machines. The emphasis will be on creative, hands-on experimentation. Along the way, students will learn the basics of embedded systems programming (Arduino), breadboarding, soldering, printed circuit board (PCB) design, mechanical computer-aided design (CAD)--both conventional (OnShape) and programmatic (OpenSCAD)--as well digital fabrication (3D-printing, laser cutting). Students will learn both how to build their own prototypes and how to send out designs to have parts machined professionally. Students will work in teams throughout. The course will culminate in a team robotic design competition testing both functionality and creativity.

Requirements/Evaluation: Evaluation based on assignments, projects, and exams.
Prerequisites: CSCI 237

Enrollment Limit: 18; 9/lab

Enrollment Preferences: Current or expected Computer Science majors

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Materials/Lab Fee: A fee of $150-$200 will be added to the term bill to cover the purchase of consumable electronics, motors, 3D-printing filament, and stock used in the assignments and final project.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will include programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025

LEC Section: 01    TR 9:55 am - 11:10 am     James M. Bern
LAB Section: 02    T 1:00 pm - 2:30 pm     James M. Bern
LAB Section: 03    T 2:30 pm - 4:00 pm     James M. Bern

CSCI 357  (S)  Algorithmic Game Theory  (QFR)

This course focuses on topics in game theory and mechanism design from a computational perspective. We will explore questions such as: how to design algorithms that incentivize truthful behavior, that is, where the participants have no incentive to cheat? Should we let drivers selfishly minimize their commute time or let a central algorithm direct traffic? Does Arrow's impossibility result mean that all voting protocols are doomed? The overarching goal of these questions is to understand and analyze selfish behavior and whether it can or should influence system design. Students will learn how to model and reason about incentives in computational systems both theoretically and empirically. Topics include types of equilibria, efficiency of equilibria, auction design and mechanism design with money, two-sided markets and mechanism design without money, incentives in computational applications such as P2P systems, and computational social choice.

Requirements/Evaluation: weekly problem sets and/or programming assignments, two midterm exams, and a final project.

Prerequisites: CSCI 256

Enrollment Limit: 24

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist problem sets and programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025

LEC Section: 01    TF 1:10 pm - 2:25 pm     Shikha Singh

CSCI 358  (F)  Applied Algorithms  (QFR)

This course is about bridging the gap between theoretical running time and writing fast code in practice. The course is divided into two basic topics. The first is algorithmic: we will discuss some of the most useful tools in a coder's toolkit. This includes topics like randomization (hashing, filters, approximate counters), linear and convex programming, similarity search, and cache-efficient algorithms. Our goal is to talk about why these efficient algorithms make seemingly difficult problems solvable in practice. The second topic is applications: we will discuss how to implement algorithms in an efficient way that takes advantage of modern hardware. Specific topics covered will include blocking, loop unrolling, pipelining, as well as strategies for performance analysis. Projects and assessments will include both basic theoretical aspects (understanding why the algorithms we discuss actually work), and practical aspects (implementing the algorithms we discuss to solve important problems, and optimizing the code so it runs as quickly as possible).

Requirements/Evaluation: Over the course of each week, there will be either a homework or an assignment. Homeworks and assignments have
similar structure, with both a coding and problem set component, but assignments will be weighted more heavily and must be completed individually. There will also be a take home final at the end of the year.

**Prerequisites:** CSCI 256 and CSCI 237

**Enrollment Limit:** 24

**Enrollment Preferences:** current or expected Computer Science majors

**Expected Class Size:** 24

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

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**CSCI 361 (F) Theory of Computation (QFR)**

**Cross-listings:** MATH 361

**Primary Cross-listing**

This course introduces a formal framework for investigating both the computability and complexity of problems. We study several models of computation including finite automata, regular languages, context-free grammars, and Turing machines. These models provide a mathematical basis for the study of computation theory--the examination of what problems can be solved and what problems cannot be solved--and the study of complexity theory--the examination of how efficiently problems can be solved. Topics include the halting problem and the P versus NP problem.

**Requirements/Evaluation:** weekly problem sets and one or more exams

**Prerequisites:** CSCI 256 or both a 300-level MATH course and permission of instructor

**Enrollment Limit:** 24

**Enrollment Preferences:** current or expected Computer Science majors

**Expected Class Size:** 24

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**

MATH 361(D3) CSCI 361(D3)

**Quantitative/Formal Reasoning Notes:** This course include regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

**Attributes:** COGS Interdepartmental Electives

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**Fall 2024**

LEC Section: 01  TF 1:10 pm - 2:25 pm  Samuel McCauley

LEC Section: 02  TR 8:30 am - 9:45 am  Shikha Singh

LEC Section: 02  TR 9:55 am - 11:10 am  Shikha Singh

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**CSCI 375 (F) Natural Language Processing (QFR)**

Natural language processing (NLP) is a set of methods for making human language accessible to computers. NLP underlies many technologies we use on a daily basis including automatic machine translation, search engines, email spam detection, and automated personalized assistants. These methods draw from a combination of algorithms, linguistics and statistics. This course will provide a foundation in building NLP models to classify, generate, and learn from text data.

**Requirements/Evaluation:** Evaluation based on assignments, projects, and exams.

**Prerequisites:** CSCI 136, and either CSCI 256 or STAT 201/202.

**Enrollment Limit:** 24
Enrollment Preferences: current or expected Computer Science majors.

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01  TR 9:55 am - 11:10 am  Katie A. Keith

CSCI 381 (F) Deep Learning (QFR)
This course is an introduction to deep neural networks and how to train them. Beginning with the fundamentals of regression and optimization, the course then surveys a variety of neural network architectures, which may include multilayer feedforward neural networks, convolutional neural networks, recurrent neural networks, and transformer networks. Students will also learn how to use deep learning software such as PyTorch or Tensorflow.

Requirements/Evaluation: Evaluation based on assignments, projects, and exams.

Prerequisites: CSCI 136 and fulfillment of the Discrete Mathematics Proficiency requirement

Enrollment Limit: 24

Enrollment Preferences: Current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01  MWF 9:00 am - 9:50 am  Mark Hopkins

ECON 110 (F)(S) Principles of Microeconomics (QFR)
This course is an introduction to the study of the forces of supply and demand that determine prices and the allocation of resources in markets for goods and services, markets for labor, and markets for natural resources. The focus is on how and why markets work, why they may fail to work, and the policy implications of both their successes and failures. The course focuses on developing the basic tools of microeconomic analysis and then applying those tools to topics of popular or policy interest such as minimum wage legislation, pollution control, competition policy, international trade policy, discrimination, tax policy, and the role of government in a market economy.

Requirements/Evaluation: problem sets, quizzes, short essays, two midterms, final exam

Prerequisites: none

Enrollment Limit: 40

Enrollment Preferences: This course is required of Economics and Political Economy majors and highly recommended for those non-majors interested in Environmental Studies and Women's, Gender and Sexuality Studies.

Expected Class Size: 40

Grading: yes pass/fail option, no fifth course option

Unit Notes: The department recommends students follow this course with ECON 120 or with a lower-level elective that has ECON 110 as its prerequisite; students may alternatively proceed directly to ECON 251 after taking this introductory course.

Distributions: (D2) (QFR)
ECON 120  (F)(S) Principles of Macroeconomics  (QFR)
This course provides an introduction to the study of the aggregate national economy. It develops the basic theories of macroeconomics and applies them to topics of current interest. Issues to be explored include: the causes of inflation, unemployment, recessions, and depressions; the role of government fiscal and monetary policy in stabilizing the economy; the determinants of long-run economic growth; the long- and short-run effects of taxes, budget deficits, and other government policies on the national economy; the role of financial frictions in amplifying recessions; and the workings of exchange rates and international finance.

Requirements/Evaluation:  Depending on instructor, may include: problem sets, short essays, quizzes, reading assignments, either one or two midterms, and a final exam.

Prerequisites:  ECON 110

Enrollment Limit:  40

Enrollment Preferences:  First-year students and sophomores.

Expected Class Size:  40

Grading:  yes pass/fail option,     yes fifth course option

Distributions:  (D2)  (QFR)

Quantitative/Formal Reasoning Notes:  Course involves mathematical modeling of real-world phenomena, analyzing quantitative results, and describing those results in words.

Attributes:  POEC Required Courses

ECON 213  (S) Introduction to Environmental and Natural Resource Economics  (QFR)

Cross-listings:  ENVI 213 / CAOS 213
Primary Cross-listing

We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

Requirements/Evaluation: problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)

Prerequisites: ECON 110 or equivalent

Enrollment Limit: 30

Enrollment Preferences: first-year and sophomore students

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Unit Notes: this course will count toward both the Environmental Studies major and concentration

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 213(D2) ENVI 213(D2) CAOS 213(D2)

Quantitative/Formal Reasoning Notes: We will use formal theory expressed in math and graphs, perform calculations, and consume statistical data.

Attributes: ENVI Environmental Policy  EVST Social Science/Policy  POEC Depth

Spring 2025

LEC Section: 01  MWF 8:30 am - 9:45 am  Sarah A. Jacobson

ECON 229  (F) Law and Economics  (QFR)

This course applies the tools of microeconomic analysis to private (i.e., civil) law. This analysis has both positive and normative aspects. The positive aspects deal with how individuals respond to the incentives created by the legal system. Examples include: how intellectual property law encourages the creation of knowledge while simultaneously restricting the dissemination of intellectual property; how tort law motivates doctors to avoid malpractice suits; and how contract law facilitates agreements. The normative aspects of the analysis ask whether legal rules enhance economic efficiency (or, more broadly, social welfare). Examples include: what legal rules are most appropriate for mitigating pollution, ensuring safe driving, and guaranteeing workplace safety? The course will also cover the economics of legal systems; for example, what are the incentives for plaintiffs to initiate lawsuits and what role do lawyers play in determining outcomes.

Class Format: discussion

Requirements/Evaluation: class participation, problem sets, paper based on actual court cases, a midterm exam, and a final exam

Prerequisites: ECON 110

Enrollment Limit: 35

Enrollment Preferences: ECON and POEC majors (and potential majors) will receive priority if the course is overenrolled

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: This course uses economic models to explore the logic of legal concepts. While some arguments will be qualitative, students will also use numerical examples to illustrate the principles of the course.

Attributes: JLST Interdepartmental Electives  POEC Depth

Fall 2024

SEM Section: 01  W 7:00 pm - 9:40 pm  William M. Gentry
ECON 232 (S) Financial Markets, Institutions and Policies (QFR)
The focus of the course will be on how firms, financial markets, and central banks interact in the economy. Key questions addressed in the course include: How do firms allocate their resources to enhance their value? How are firms evaluated by the financial markets? How are asset prices determined, and how are these prices related to interest rates? Are financial markets efficient, and what are the implications of their efficiency or lack thereof? How does the financial system help with the management of risks faced by society? We will also study the role of the central bank (the Federal Reserve in the US), monetary policy, and government regulation and their impacts on financial decision making. Key questions include: How do central banks set monetary policy and how do those policies affect the economy and the financial decision-making process? How does monetary policy change when interest rates are (virtually) zero?

Class Format: There will be a mix of lecture and discussion.

Requirements/Evaluation: 5-7 Problem Sets, Quantitative Exercises, Group Paper, and Final Exam

Prerequisites: ECON 110 and ECON 120

Enrollment Limit: 25

Enrollment Preferences: Sophomore and Junior Economics majors

Expected Class Size: 25

Grading: yes pass/fail option, no fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: We will use mathematical models, graphs, and data analysis to understand financial decisions at the firm and economy-wide levels.

Attributes: POEC Depth

Spring 2025
LEC Section: 01 TR 11:20 am - 12:35 pm Nate Vellekoop

ECON 251 (F)(S) Price and Allocation Theory (QFR)
A study of the determination of relative prices and their importance in shaping the allocation of resources and the distribution of income. Subjects include: behavior of households in a variety of settings, such as buying goods and services, saving, and labor supply; behavior of firms in various kinds of markets: results of competitive and noncompetitive markets in goods, labor, land, and capital; market failure; government policies as sources of and responses to market failure; welfare criteria; limitations of mainstream analysis.

Requirements/Evaluation: Requirements vary by professor, but typically include frequent problem sets and multiple exams, including a final exam. They may also include one or more quizzes, short essays, collaborative projects, or presentations.

Prerequisites: ECON 110 and MATH 130 or its equivalent

Enrollment Limit: 30

Enrollment Preferences: Current or prospective Economics majors.

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: Course involves developing and analyzing mathematical models of real-world phenomena, grounded in tools like calculus and game theory. Students are assumed to be comfortable with topics from introductory calculus, including differentiation and integration.

Fall 2024
LEC Section: 01 MR 1:10 pm - 2:25 pm Greg Phelan
LEC Section: 02 MR 2:35 pm - 3:50 pm Greg Phelan
LEC Section: 03 TF 1:10 pm - 2:25 pm Ethan Holdahl

Spring 2025
LEC Section: 01 TR 9:55 am - 11:10 am Greg Phelan
LEC Section: 02 MR 1:10 pm - 2:25 pm Sara LaLumia
ECON 252 (F)(S) Macroeconomics (QFR)
A study of aggregate economic activity: output, employment, inflation, and interest rates. The class will develop a theoretical framework for analyzing economic growth and business cycles. The theory will be used to evaluate policies designed to promote growth and stability, and to understand economic developments in the U.S. and abroad. Instructors may use elementary calculus in assigned readings, exams and lectures.

Requirements/Evaluation: Requirements vary by professor, but typically include frequent problem sets and/or written assignments, midterm(s), and a final exam.
Prerequisites: ECON 110 and 120 and MATH 130 or its equivalent
Enrollment Limit: 30
Enrollment Preferences: Current or prospective Economics majors.
Expected Class Size: 30
Grading: yes pass/fail option, no fifth course option
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: Course involves mathematical modeling of real-world phenomena, analyzing quantitative results, and describing those results in words.

Fall 2024
LEC Section: 01 TR 8:30 am - 9:45 am Kenneth N. Kuttner
LEC Section: 02 MR 1:10 pm - 2:25 pm Burak Uras
LEC Section: 03 MR 2:35 pm - 3:50 pm Burak Uras

Spring 2025
LEC Section: 01 MWF 8:30 am - 9:45 am Kenneth N. Kuttner
LEC Section: 02 MWF 11:00 am - 12:15 pm Kenneth N. Kuttner

ECON 255 (F)(S) Econometrics (QFR)
An introduction to the theory and practice of applied quantitative economic analysis. This course familiarizes students with the strengths and weaknesses of the basic empirical methods used by economists to evaluate economic theory against economic data. Emphasizes both the statistical foundations of regression techniques and the practical application of those techniques in empirical research, with a focus on understanding when a causal interpretation is warranted. Computer exercises will provide experience in using the empirical methods, but no previous computer experience is expected. Highly recommended for students considering graduate training in economics or public policy.

Requirements/Evaluation: Requirements vary by professor, but typically include frequent problem sets, multiple exams, a group project, and possible additional assignments or quizzes.
Prerequisites: MATH 130, plus STAT 161, 201 or 202 (or equivalent, including a score of 5 on the AP Statistics Exam), plus one course in ECON; STAT 101 will also serve as a prerequisite, but only if taken prior to the fall of 2018
Enrollment Limit: 30
Enrollment Preferences: Current or prospective Economics and Political Economy majors.
Expected Class Size: 30
Grading: no pass/fail option, no fifth course option
Unit Notes: Students may substitute the combination of STAT 201 and 346 for ECON 255
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: Course teaches research tools necessary to analyze data.
Attributes: POEC Required Courses
Evidence from across the developing world suggests that the "binding constraints" to economic growth can be remarkably heterogeneous—i.e., the growth potential of stagnating or underperforming economies may be unlocked in a large variety of ways. For instance, pre-reform China had been constrained by poor supply incentives in agriculture, whereas Brazil has been held back by an inadequate supply of credit, South Africa by poor employment incentives in manufacturing, El Salvador by insufficient production incentives in tradables, Zimbabwe by bad governance, and so forth.

How can developing-country policymakers determine country-specific constraints like these, thus enabling them to pragmatically pursue a selected set of growth-promoting policies rather than attempting to implement a "laundry list" of reforms that are naively based on "best practice" rules-of-thumb? This course will serve as a primer on "growth diagnostics," an empirically-driven analytical framework for identifying the most binding constraints to economic growth in a given country at a point in time, thereby allowing policymakers to develop well-targeted reforms for relaxing these constraints while being cognizant of the nation's prevailing economic, political, and social context. The course will first build on the basic theories and empirics of economic growth to elucidate the diagnostic framework and will then employ a wide range of country-specific case studies to demonstrate how the framework can be operationalized for policy making. Throughout the semester, students will be required to work in groups, each representing a given developing or emerging-market economy, in order to build a growth diagnostic for their group's assigned country by the end of the course.

Requirements/Evaluation: extensive class participation, several short (5-page) reports, a final group project comprising a country growth diagnostic, and a final group presentation on the diagnostic

Prerequisites: for undergraduates ECON 251, ECON 252, and either ECON 255 or STAT 346

Enrollment Limit: 19

Enrollment Preferences: CDE fellows and senior Economics majors

Expected Class Size: 19

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 345(D2) ECON 545(D2)

Quantitative/Formal Reasoning Notes: The course material will be draw heavily on mathematical and statistical models of economic growth and macroeconomic development, and students will be required to routinely develop mathematical models and/or conduct econometric analysis in their assignments.
Enrollment Preferences: Economics majors

Expected Class Size: 25

Grading: no pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: uses extensive mathematical modeling, including engaging with results from econometrics and statistics

Spring 2025
LEC Section: 01    TR 8:30 am - 9:45 am     Greg Phelan

**ECON 367** (S) The Political Economy of Social Insurance    (WS) (QFR)
The Great Society policies of the 1960s dramatically changed the ways people living in poverty interacted with the federal government, but the benefits associated with these policies seem to have stagnated. Since 1965, the annual poverty rate in the United States has hovered between 10% and 15%, though far more than 15% of Americans experience poverty at some point in their lives. In this course, we will study public policies that, explicitly or implicitly, have as a goal improving the well-being of the poor in the United States. These policies include social insurance programs such as Unemployment Insurance; safety net programs such as Temporary Assistance to Needy Families, Supplemental Nutrition Assistance Program, Medicaid, and housing assistance; education programs such as Head Start and public education; and parts of the tax code, including the Earned Income Tax Credit and Child Tax Credit. We will explore the design and function of these programs, with a particular focus on the context in which they were developed. What political incentives and constraints have strung up our social safety net? How do these factors affect the goals of policy, the trade-offs inherent to the policy's design, and why poverty has not sustained a downward trend in the United States? Through careful consideration, students will learn how to communicate a path forward for public policy which accounts for theoretical economic expectations and the reality of political constraints in policy design.

Class Format: Lecture with substantial class discussion.

Requirements/Evaluation: Several short policy memos, participation in class discussion, and a final analytical essay.

Prerequisites: ECON 253 or 255

Enrollment Limit: 25

Enrollment Preferences: Students majoring in economics or political economy.

Expected Class Size: 25

Grading: no pass/fail option, yes fifth course option

Distributions: (D2) (WS) (QFR)

Writing Skills Notes: Students will write 4 policy memos over the course of the semester followed by a longer, final analytical essay. Synthesis of peer-reviewed literature, use of citation management systems, and clarity in technical writing will be emphasized. Students will receive timely, substantial, individualized feedback to develop their technical writing ability over the course of the semester. Opportunities to meet with professor outside of class at any stage of writing.

Quantitative/Formal Reasoning Notes: This course will use quantitative tools of economics. Focus on building data visualization & science communication skills after ECON 255.

Attributes: POEC Skills

Spring 2025
LEC Section: 01    TF 2:35 pm - 3:50 pm     Shyam Raman

**ECON 371** (F) Time Series Econometrics and Empirical Methods for Macro    (QFR)
Econometric methods in many fields including macro and monetary economics, finance and international growth and development, as well as numerous fields beyond economics, have evolved a distinct set of techniques which are designed to meet the practical challenges posed by the typical empirical questions and available time series data of these fields. The course will begin with an introductory review of concepts of estimation and inference for large data samples in the context of the challenges of multivariate endogenous systems, and will then focus on associated methods for analysis of short run dynamics such as vector autoregressive techniques and methods for analysis of long run dynamics such as cointegration techniques. Students will be introduced to concepts and techniques analytically, but also by intuition, learning by doing, and by computer simulation...
and illustration. The course is particularly well suited for economics majors wishing to explore advanced empirical methods, or for statistics, mathematics or computer science majors wishing to learn more about the ways in which the subject of their majors interacts with the field of economics. The method of evaluation will include a term paper. ECON 252 and either STATS 346 or ECON 255 are formal prerequisites, although for students with exceptionally strong math/stats backgrounds these can be waived subject to instructor permission. Students who complete this course will also be permitted to enroll in Econ 471 (a follow up senior seminar course) during the spring semester if they are interested.

**Requirements/Evaluation:** term paper and regular homework assignments

**Prerequisites:** ECON 252 and either ECON 255 or STATS 346

**Enrollment Limit:** 19

**Enrollment Preferences:** students wishing to write an honors thesis, and students with strong MATH/STAT/CSCI backgrounds

**Expected Class Size:** 19

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** Uses quantitative/formal reasoning intensively in the form of mathematical and statistical arguments, as well as computer programming.

Fall 2024

SEM Section: 01  W 7:00 pm - 9:40 pm  Peter L. Pedroni

**ECON 384 (F) Corporate Finance** (QFR)

This course analyzes the major financial decisions facing firms. While the course takes the perspective of a manager making decisions about both what investments to undertake and how to finance these projects, it will emphasize the underlying economic models that are relevant for these decisions. Topics include capital budgeting, links between real and financial investments, capital structure choices, dividend policy, and firm valuation.

**Class Format:** Lecture / discussion

**Requirements/Evaluation:** Problem sets, exams, short project

**Prerequisites:** ECON 251, 252, and some familiarity with statistics (e.g., ECON 255)

**Enrollment Limit:** 25

**Enrollment Preferences:** Economics majors; seniority

**Expected Class Size:** 25

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** The course uses quantitative models to evaluate decisions.

Fall 2024

LEC Section: 01  MWF 11:00 am - 12:15 pm  Caitlin E. Hegarty

**ECON 385 (F) Games and Information** (QFR)

This course is a mathematical introduction to strategic thinking and its applications. Ideas from game theory, including Nash equilibrium and its refinements, commitment and credibility, repeated games, and information asymmetries, incentive contracts, and signaling, will be introduced. Applications will be drawn from economics, history, and politics around the globe, and include topics such as: trust between strangers, corruption and fraud, racial bias, violence and deterrence. And we will explore how to write and recognize game-theory models to help make sense of strategic interactions in the world around us.

**Requirements/Evaluation:** Two exams, regular problem sets and assignments in which students create game-theoretic models.

**Prerequisites:** ECON 251 or permission of instructor

**Enrollment Limit:** 25

**Enrollment Preferences:** juniors
ECON 389 (S) Tax Policy in Global Perspective  (QFR)

Cross-listings:

Secondary Cross-listing

Government policy is important for economic development. To finance their policies, governments must build the fiscal capacity to implement a tax system. In turn, fiscal capacity—the ability for the government to raise revenue—depends on economic development. This endogeneity between fiscal capacity and economic development creates challenges for tax policy in developing countries. Given these challenges, what types of taxes should countries use to raise revenues? How can governments build the fiscal capacity to generate revenue to finance critical services? This class explores tax policy from a global and comparative perspective. Because most students will be CDE fellows, we will emphasize tax policy issues, examples, and evidence that are pertinent to developing countries. However, many tax policy lessons are universal so we will also learn about tax policies in developed countries, especially issues relevant for transnational transactions. Topics addressed include: how economic principles can be applied to the efficiency and equity consequences of tax policies; how personal income taxes, corporate income taxes, and value-added taxes are designed and administered and how they influence the economy; ideas for fundamental tax reforms; the debate over progressive taxes versus "flat" taxes; how taxes affect incentives to save and invest; how market failures and administrative problems may influence the optimality of tax policy; the implications of global capital flows and corporate tax avoidance for tax policy; tax holidays and other special tax incentives for investment; empirical evidence on the influence of taxes on foreign direct investment, labor supply, and tax evasion; tax policy towards natural resources such as minerals and oil; case studies of efforts to reform tax administration and reduce tax evasion and corruption; taxes on land and property; taxes on imports and exports; presumptive taxation; and the informal economy and its implications for tax policy.

Requirements/Evaluation: midterm exam, several problem sets, two 10-page essays

Prerequisites: one public economics course or microeconomics course (ECON 504 or ECON 110), and one empirical methods course (POEC 253 or ECON 255, 502, or 503); students who have previously taken ECON 351 will not be enrolled

Enrollment Limit: 19

Enrollment Preferences: CDE students, but undergraduates with the prerequisites are welcome

Expected Class Size: 15-19

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 389(D2) ECON 514(D2)

Quantitative/Formal Reasoning Notes: The course builds on other QFR Reasoning econ classes.

Attributes: POEC Depth POEC Skills

Spring 2025

SEM Section: 01  MR 2:35 pm - 3:50 pm  Jon M. Bakija

ECON 454 (F) Macroeconomic Perspectives on Labor Markets  (QFR)

This seminar will cover aggregate trends in the labor market from a macroeconomic perspective, along with the tools that economists use to study them. We will think about the workforce as a whole but we will also highlight research that studies heterogeneity within the economy, such as patterns by race, gender, education, or occupation. Students will learn basic search and matching models, as well as related empirical methods. We will read papers that employ a variety of survey and administrative data, and we will discuss what types of research questions are best answered by each data
source. We will use real data to apply the methods we learn. Potential topics include occupational mismatch, wage inequality, and monopsony.

**Requirements/Evaluation:** Class participation, short assignments, midterm exam, and a final project.

**Prerequisites:** Econ 251, 252, and 255

**Enrollment Limit:** 19

**Enrollment Preferences:** Junior and senior economics majors

**Expected Class Size:** 19

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** Course includes regular problem sets that require quantitative and formal reasoning skills.

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Fall 2024

SEM Section: 01 MWF 8:30 am - 9:45 am Caitlin E. Hegarty

**ECON 471 (S) Topics in Advanced Econometrics** (QFR)

The course uses both a practical and conceptual/theory based approach, with emphasis on methods of structural identification of dynamics in VARs and long run cointegration and nonlinear function estimation and analysis, both in conventional time series and especially panel time series which contain spatial dimensions. The course will also investigate methods of computer simulation related to these techniques. The course is well suited for students considering empirically oriented honors theses in fields that employ these techniques, such as macro, finance, growth, trade and development, as well as fields outside of economics that use time series data. It is also well suited for students majoring in economics, statistics, computer sciences or mathematics who wish to expand their econometrics training and understanding to a more advanced level.

**Requirements/Evaluation:** periodic homework assignments, term paper.

**Prerequisites:** ECON 371

**Enrollment Limit:** 19

**Enrollment Preferences:** students with strong quantitative backgrounds, and to students intending to write an honors thesis

**Expected Class Size:** 19

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** Course will make use of mathematics, statistics and computer analysis for the conceptualization and implementation of the econometric topics that are taught.

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Spring 2025

SEM Section: 01 W 7:00 pm - 9:40 pm Peter L. Pedroni

**ECON 477 (F) Economics of Environmental Behavior** (QFR)

**Cross-listings:** CAOS 477 / ENVI 376

**Primary Cross-listing**

A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.

**Class Format:** Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities.

**Requirements/Evaluation:** class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory.
ECON 514 (S) Tax Policy in Global Perspective (QFR)

Cross-listings:

Government policy is important for economic development. To finance their policies, governments must build the fiscal capacity to implement a tax system. In turn, fiscal capacity—the ability for the government to raise revenue—depends on economic development. This endogeneity between fiscal capacity and economic development creates challenges for tax policy in developing countries. Given these challenges, what types of taxes should countries use to raise revenues? How can governments build the fiscal capacity to generate revenue to finance critical services? This class explores tax policy from a global and comparative perspective. Because most students will be CDE fellows, we will emphasize tax policy issues, examples, and evidence that are pertinent to developing countries. However, many tax policy lessons are universal so we will also learn about tax policies in developed countries, especially issues relevant for transnational transactions. Topics addressed include: how economic principles can be applied to the efficiency and equity consequences of tax policies; how personal income taxes, corporate income taxes, and value-added taxes are designed and administered and how they influence the economy; ideas for fundamental tax reforms; the debate over progressive taxes versus "flat" taxes; how taxes affect incentives to save and invest; how market failures and administrative problems may influence the optimality of tax policy; the implications of global capital flows and corporate tax avoidance for tax policy; tax holidays and other special tax incentives for investment; empirical evidence on the influence of taxes on foreign direct investment, labor supply, and tax evasion; tax policy towards natural resources such as minerals and oil; case studies of efforts to reform tax administration and reduce tax evasion and corruption; taxes on land and property; taxes on imports and exports; presumptive taxation; and the informal economy and its implications for tax policy.

Requirements/Evaluation: midterm exam, several problem sets, two 10-page essays

Prerequisites: one public economics course or microeconomics course (ECON 504 or ECON 110), and one empirical methods course (POEC 253 or ECON 255, 502, or 503); students who have previously taken ECON 351 will not be enrolled

Enrollment Limit: 19

Enrollment Preferences: CDE students, but undergraduates with the prerequisites are welcome

Expected Class Size: 15-19

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 389(D2) ECON 514(D2)

Quantitative/Formal Reasoning Notes: The course builds on other QFR Reasoning econ classes.

Attributes: POEC Depth POEC Skills
ECON 545 (S) Growth Diagnostics (QFR)

Cross-listings:

Secondary Cross-listing

Evidence from across the developing world suggests that the "binding constraints" to economic growth can be remarkably heterogeneous—i.e., the growth potential of stagnating or underperforming economies may be unlocked in a large variety of ways. For instance, pre-reform China had been constrained by poor supply incentives in agriculture, whereas Brazil has been held back by an inadequate supply of credit, South Africa by poor employment incentives in manufacturing, El Salvador by insufficient production incentives in tradables, Zimbabwe by bad governance, and so forth. How can developing-country policymakers determine country-specific constraints like these, thus enabling them to pragmatically pursue a selected set of growth-promoting policies rather than attempting to implement a "laundry list" of reforms that are naively based on "best practice" rules-of-thumb? This course will serve as a primer on "growth diagnostics," an empirically-driven analytical framework for identifying the most binding constraints to economic growth in a given country at a point in time, thereby allowing policymakers to develop well-targeted reforms for relaxing these constraints while being cognizant of the nation's prevailing economic, political, and social context. The course will first build on the basic theories and empirics of economic growth to elucidate the diagnostic framework and will then employ a wide range of country-specific case studies to demonstrate how the framework can be operationalized for policy making. Throughout the semester, students will be required to work in groups, each representing a given developing or emerging-market economy, in order to build a growth diagnostic for their group's assigned country by the end of the course.

Requirements/Evaluation: extensive class participation, several short (5-page) reports, a final group project comprising a country growth diagnostic, and a final group presentation on the diagnostic

Prerequisites: for undergraduates ECON 251, ECON 252, and either ECON 255 or STAT 346

Enrollment Limit: 19

Enrollment Preferences: CDE fellows and senior Economics majors

Expected Class Size: 19

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 345(D2) ECON 545(D2)

Quantitative/Formal Reasoning Notes: The course material will be draw heavily on mathematical and statistical models of economic growth and macroeconomic development, and students will be required to routinely develop mathematical models and/or conduct econometric analysis in their assignments.

Spring 2025

SEM Section: 01 TR 9:55 am - 11:10 am Quamrul H. Ashraf

ENVI 108 (S) Energy Science and Technology (QFR)

Cross-listings: PHYS 108

Secondary Cross-listing

Energy use has skyrocketed in the United States and elsewhere in the world, causing significant economic and political shifts, as well as concerns for the environment. This course will address the physics and technology of energy generation, consumption, and conservation. It will cover a wide range of energy sources, including fossil fuels, hydropower, solar energy, wind energy, and nuclear energy. We will discuss energy use in transportation, manufacturing, building heating and lighting, and energy storage. Students will learn to compare the efficiencies and environmental impacts of various energy sources and uses.

Class Format: Two meetings per week. Some weeks that means two lectures. Other weeks, that means one lecture plus one lab, with the class divided between two lab sections.

Requirements/Evaluation: weekly assignments, two hour tests, and a final project culminating in an oral presentation to the class and a 10-page paper; all of these will be substantially quantitative

Prerequisites: high school physics, high school chemistry, and mathematics at the level of MATH 130

Enrollment Limit: 10 per lab
Enrollment Preferences: non-physics majors

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ENVI 108(D3) PHYS 108(D3)

Quantitative/Formal Reasoning Notes: problems sets, exams, and projects will all have a quantitative aspects.

Attributes: ENVI Natural World Electives

Spring 2025

LEC Section: 01  MR 1:10 pm - 2:25 pm  Protik K. Majumder
LAB Section: 02  R 1:10 pm - 2:25 pm  Protik K. Majumder
LAB Section: 03  R 2:25 pm - 3:50 pm  Protik K. Majumder

ENVI 203 (F) Ecology (QFR)

Cross-listings: BIOL 203

Secondary Cross-listing

This course combines lectures & discussion with field and indoor laboratory activities to explore factors that determine the distribution and abundance of plants and animals in natural systems. The course begins with an overview of global environmental patterns and then builds from the population to ecosystem level. Throughout the course, we will emphasize the connection between basic ecological principles and current environmental issues. Selected topics include population dynamics (competition, predation, mutualism); community interactions (succession, food chains and diversity) and ecosystem function (biogeochemical cycles, energy flow). Laboratory activities are designed to engage students in the natural history of the region and build skills in data analysis and scientific writing.

Requirements/Evaluation: pre-class quizzes, lab reports, two mid-term exams, and a final exam

Prerequisites: BIOL 102, or ENVI 102, or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: students planning to pursue Biology and/or ENVI

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 203(D3) ENVI 203(D3)

Quantitative/Formal Reasoning Notes: Much of the material in this course centers on the interpretation and application of mathematical models used to describe ecological systems. The laboratory section of this course also contains a large data analysis component (based in R). Students are introduced to linear models, multidimensional data analysis and contingency tables.

Attributes: ENVI Natural World Electives  EVST Environmental Science

Fall 2024

LEC Section: 01  TR 8:30 am - 9:45 am  Manuel A. Morales
LAB Section: 02  T 1:00 pm - 3:50 pm  Manuel A. Morales
LAB Section: 03  W 1:00 pm - 3:50 pm  Manuel A. Morales

ENVI 213 (S) Introduction to Environmental and Natural Resource Economics (QFR)

Cross-listings: ECON 213 / CAOS 213

Secondary Cross-listing
We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

**Requirements/Evaluation:** problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)

**Prerequisites:** ECON 110 or equivalent

**Enrollment Limit:** 30

**Enrollment Preferences:** first-year and sophomore students

**Expected Class Size:** 30

**Grading:** yes pass/fail option, yes fifth course option

**Unit Notes:** this course will count toward both the Environmental Studies major and concentration

**Distributions:** (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 213(D2) ENVI 213(D2) CAOS 213(D2)

**Quantitative/Formal Reasoning Notes:** We will use formal theory expressed in math and graphs, perform calculations, and consume statistical data.

**Attributes:** ENVI Environmental Policy EVST Social Science/Policy POEC Depth

Spring 2025

LEC Section: 01 MWF 8:30 am - 9:45 am Sarah A. Jacobson

**ENVI 327 (F) Coastal Processes and Geomorphology** (QFR)

**Cross-listings:** GEOS 327 / CAOS 327

**Secondary Cross-listing**

Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces--wind, waves, storms, and people--that shape the coastal zone, as well as the geologic formations--sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs--that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change. Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

**Class Format:** lecture two times a week with a lab one time per week

**Requirements/Evaluation:** lab reports, quizzes, and an independent research project

**Prerequisites:** Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.

**Enrollment Limit:** 15

**Enrollment Preferences:** Geosciences majors

**Expected Class Size:** 15
ENVI 376 (F) Economics of Environmental Behavior (QFR)

**Cross-listings:** CAOS 477 / ECON 477

**Secondary Cross-listing**
A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.

**Class Format:** Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities

**Requirements/Evaluation:** class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory

**Prerequisites:** ECON 251 and (ECON 255 or STAT 346)

**Enrollment Limit:** 19

**Enrollment Preferences:** senior Economics majors and junior Economics majors considering a thesis

**Expected Class Size:** 19

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**
CAOS 477(D2) ENVI 376(D2) ECON 477(D2)

**Quantitative/Formal Reasoning Notes:** The research students will consume and produce in the class will be based on math-based theory and/or econometric-based empirical analysis.

**Attributes:** CAOS Senior Seminars  ENVI Humanities, Arts + Social Science Electives  POEC Depth  POEC Skills

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**Fall 2024**

**LEC Section:** 01  MWF 8:30 am - 9:45 am  Alex A. Apotsos

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**GEOS 234 (S) Introduction to Materials Science** (QFR)

**Cross-listings:** PHYS 234

**Secondary Cross-listing**
Materials Science is the study of how the microscopic structure of materials--whether steel, carbon fiber, glass, wood, plastic, or mayonnaise--determines their macroscopic mechanical, thermal, electric, and other properties. Topics of this course include classifying materials; material structure; thermodynamics and phase transformations; material properties and testing; how solids bend, flow, and ultimately break; and how...
to choose the right material for design applications. Materials Science is a highly interdisciplinary field and as a result the course prerequisites are broad but also flexible. Interested students who are unsure about their preparation are strongly encouraged to contact the instructor.

Class Format: lecture (3 hours per week) plus three to four small-group laboratory sessions throughout the semester (to be scheduled with instructor)

Requirements/Evaluation: weekly problem sets, class participation, and midterm and final exams, all of which have a substantial quantitative component

Prerequisites: high school physics and chemistry, preferably at the AP level, and MATH 140 or AP Calculus (BC), and one 200-level PHYS, CHEM, or GEOS course; or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: based on students’ scientific background and seniority

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Unit Notes: This course does not count toward the Geosciences major.

Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

PHYS 234(D3) GEOS 234(D3)

Quantitative/Formal Reasoning Notes: Weekly problem sets and exams all have a substantial quantitative component.

Attributes: MTSC Courses

Spring 2025

LEC Section: 01  MR 2:35 pm - 3:50 pm  Katharine E. Jensen

GEOS 327  (F)  Coastal Processes and Geomorphology  (QFR)

Cross-listings: ENVI 327 / CAOS 327

Primary Cross-listing

Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces—wind, waves, storms, and people—that shape the coastal zone, as well as the geologic formations—sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs—that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change.

Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week

Requirements/Evaluation: lab reports, quizzes, and an independent research project

Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.

Enrollment Limit: 15

Enrollment Preferences: Geosciences majors

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option
This course is cross-listed and the prefixes carry the following divisional credit:

ENVI 327(D3) GEOS 327(D3) CAOS 327(D3)

Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.

Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life

Fall 2024
LEC Section: 01 MWF 8:30 am - 9:45 am Alex A. Apotsos

INTR 150 (F) Data for Justice (DPE) (QFR)
Cross-listings: STS 150 / AMST 150 / SOC 150 / WGSS 150

Primary Cross-listing
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

Class Format: This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18

Enrollment Preferences: Students without prior college-level courses in statistics and programming.

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz
LEC Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz

INTR 350 (S) Data for Justice Research Practicum (DPE) (QFR)
Cross-listings: WGSS 363 / STS 363 / AMST 363

Primary Cross-listing

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10

Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor's preregistration survey (contact the instructor for link).

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

Difference, Power, and Equity Notes: Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

Quantitative/Formal Reasoning Notes: Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 01  TR 9:55 am - 11:10 am  Chad M. Topaz
SEM Section: 02  TR 11:20 am - 12:35 pm  Chad M. Topaz

MATH 113  (S)  The Beauty of Numbers  (QFR)

This course will be an introduction to number theory and mathematical thinking and logic, with emphasis throughout on mathematics as a way of thinking and approaching the world. Have you ever wondered what keeps your credit card information safe every time you buy something online? Number theory! Number Theory is one of the oldest branches of mathematics. In this course, we will discover the beauty and usefulness of numbers, from ancient Greece to modern cryptology. We will look for patterns, make conjectures, and learn how to prove these conjectures. Starting with nothing more than basic high school algebra, we will develop the logic and critical thinking skills required to realize and prove mathematical results. Topics to be covered include the meaning and content of proof, prime numbers, divisibility, rationality, modular arithmetic, Fermat's Last Theorem, the Golden ratio, Fibonacci numbers, coding theory, and unique factorization. This course is meant to give you an appreciation for numbers and mathematics and to enhance your logical reasoning skills. Although most people will not use calculus or geometry in their jobs or everyday lives, mathematics enhances our abilities to think logically and reason effectively. This skill is useful in all aspects of life. Number theory, in particular, is a great area of mathematics that allows one to jump in right away without a lot of pre-requisite knowledge. We will look at examples, look for patterns, make conjectures, and we will spend a lot of time learning how to rigorously prove those conjectures.

Requirements/Evaluation: projects, homework assignments, and exams

Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test) or permission of instructor. Anyone who has previously taken a 200-level math course or higher must obtain instructor permission to take the course.

Enrollment Limit: 25

Enrollment Preferences: If over-enrolled, course selection will be based on answers to a questionnaire.

Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: proof writing and logic

Spring 2025
LEC Section: 01 TR 11:20 am - 12:35 pm Allison Pacelli

MATH 130 (F)(S) Calculus I (QFR)
Calculus permits the computation of velocities and other instantaneous rates of change by a limiting process called differentiation. The same process also solves "max-min" problems: how to maximize profit or minimize pollution. A second limiting process, called integration, permits the computation of areas and accumulations of income or medicines. The Fundamental Theorem of Calculus provides a useful and surprising link between the two processes. Subtopics include trigonometry, exponential growth, and logarithms.

Requirements/Evaluation: Weekly homework and quizzes, 2 exams during the semester, and one final
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test); this is an introductory course for students who have not seen calculus before
Enrollment Limit: 50
Enrollment Preferences: first-year students
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Unit Notes: students who have previously taken a calculus course may not enroll in MATH 130 without the permission of instructor
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This a calculus course.

Fall 2024
LEC Section: 01 MWF 8:00 am - 8:50 am Lori A. Pedersen
LEC Section: 02 MWF 9:00 am - 9:50 am Lori A. Pedersen
Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Leo Goldmakher

MATH 140 (F)(S) Calculus II (QFR)
Calculus answers two basic questions: how fast is something changing (the derivative) and how much is there (the integral). This course is about integration, and the miracle that unites the derivative and the integral (the Fundamental Theorem of Calculus.) Understanding calculus requires in part the understanding of methods of integration. This course will also solve equations involving derivatives ("differential equations") for population growth or pollution levels. Exponential and logarithmic functions and trigonometric and inverse functions will also play an important role. This course is the right starting point for students who have seen derivatives, but not necessarily integrals, before.

Requirements/Evaluation: homework, quizzes, and/or exams
Prerequisites: MATH 130 or equivalent; students who have received the equivalent of advanced placement of AB 4, BC 3 or higher may not enroll in MATH 140 without the permission of instructor
Enrollment Limit: 50
Enrollment Preferences: based on who needs calculus the soonest
Expected Class Size: 30
Grading: yes pass/fail option, yes fifth course option
Unit Notes: students who have higher advanced placement must enroll in MATH 150 or above
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is a math class
MATH 150  (F)/(S)  Multivariable Calculus  (QFR)
Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives, multiple integrals. There is also a unit on infinite series, sometimes with applications to differential equations.

Requirements/Evaluation:  Problem sets and exams
Prerequisites:  MATH 140 or equivalent, such as satisfactory performance on an Advanced Placement Examination
Enrollment Limit:  50
Enrollment Preferences:  Preference will be given to prospective math and stats majors, or students who need this as a course to serve as a prerequisite for other courses.
Expected Class Size:  40
Grading:  yes pass/fail option,  yes fifth course option
Unit Notes:  Students with the equivalent of advanced placement of AB 4 or above should enroll in MATH 150, students with a BC 3 or higher should enroll in Math 151 when it is being offered, and Math 150 otherwise.
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  mathematics

MATH 151  (F)  Multivariable Calculus  (QFR)
Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives and multiple integrals. The goal of the course is Stokes Theorem, a deep and profound generalization of the Fundamental Theorem of Calculus. The difference between this course and MATH 150 is that MATH 150 covers infinite series instead of the theorems of vector calculus. Students with the equivalent of BC 3 or higher should enroll in MATH 151, as well as students who have taken the equivalent of an integral calculus and who have already been exposed to infinite series. For further clarification as to whether MATH 150 or MATH 151 is appropriate, please consult a member of the math/stat department.

Requirements/Evaluation:  problem sets and exams
Prerequisites:  AP BC 3 or higher or integral calculus with infinite series
Enrollment Limit:  50
Enrollment Preferences:  First-years, sophomores, and juniors
Expected Class Size:  40
Grading:  yes pass/fail option,  yes fifth course option
Unit Notes:  MATH 151 satisfies any MATH 150 prerequisite; credit will not be given for both MATH 150 and MATH 151
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  This course builds quantitative skills
Fall 2024
LEC Section: 01    MWF 9:00 am - 9:50 am     Susan R. Loepp
LEC Section: 02    MWF 10:00 am - 10:50 am     Susan R. Loepp
LEC Section: 03    MWF 11:00 am - 11:50 am     Susan R. Loepp

MATH 200  (F)(S) Discrete Mathematics  (QFR)
In contrast to calculus, which is the study of continuous processes, this course examines the structure and properties of finite sets. Topics to be covered include mathematical logic, elementary number theory, mathematical induction, set theory, functions, relations, elementary combinatorics and probability, and graphs. Emphasis will be given on the methods and styles of mathematical proofs, in order to prepare the students for more advanced math courses.

Class Format: This will not be a typical lecture course; instead it will be a blend of lecture and discovery-based learning, with weekly small group meetings with TA's.

Requirements/Evaluation: Spring: Evaluation will be based on homework, exams, and participation in weekly small group meetings.

Prerequisites: Calculus at the level of an AP course or Williams College Math 130 or 140. Students who have taken a 300-level or 400-level math course should obtain permission of the instructor before enrolling.

Enrollment Limit: 40
Enrollment Preferences: Preference given to first and second year students intending to major in mathematics or computer science.

Expected Class Size: 40
Grading:  yes pass/fail option,  yes fifth course option
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This course involves developing the formal mathematical language of logic and set theory. It also involves using quantitative tools to solve problems relating to combinatorics, probability, number theory, and other fields of discrete mathematics.

Fall 2024
LEC Section: 01    TR 9:55 am - 11:10 am     Palak  Arora
LEC Section: 02    TR 11:20 am - 12:35 pm     Palak  Arora

Spring 2025
LEC Section: 01    TR 8:30 am - 9:45 am     Lori A. Pedersen
LEC Section: 02    TR 9:55 am - 11:10 am     Lori A. Pedersen

MATH 210  (S) Mathematical Methods for Scientists  (QFR)
Cross-listings: PHYS 210
Secondary Cross-listing
This course covers a variety of mathematical methods used in the sciences, focusing particularly on the solution of ordinary and partial differential equations. In addition to calling attention to certain special equations that arise frequently in the study of waves and diffusion, we develop general techniques such as looking for series solutions and, in the case of nonlinear equations, using phase portraits and linearizing around fixed points. We study some simple numerical techniques for solving differential equations. An optional session in Mathematica will be offered for students who are not already familiar with this computational tool.

Class Format: three hours per week
Requirements/Evaluation: several exams and weekly problem sets, all of which have a substantial quantitative component
Prerequisites: MATH 150 or 151 and familiarity with Newtonian mechanics at the level of PHYS 131
Enrollment Limit: 50
Enrollment Preferences: sophomores and juniors
Expected Class Size: 30
Grading:  yes pass/fail option,  yes fifth course option
Distributions: (D3)  (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
PHYS 210(D3) MATH 210(D3)

Quantitative/Formal Reasoning Notes: This course will have weekly problem sets using advanced calculus methods

Spring 2025
LEC Section: 01 TR 9:55 am - 11:10 am Frederick W. Strauch

MATH 250 (F)(S) Linear Algebra (QFR)
Many social, political, economic, biological, and physical phenomena can be described, at least approximately, by linear relations. In the study of systems of linear equations one may ask: When does a solution exist? When is it unique? How does one find it? How can one interpret it geometrically? This course develops the theoretical structure underlying answers to these and other questions and includes the study of matrices, vector spaces, linear independence and bases, linear transformations, determinants and inner products. Course work is balanced between theoretical and computational, with attention to improving mathematical style and sophistication.

Requirements/Evaluation: homework and exams
Prerequisites: MATH 150/151 or MATH 200
Enrollment Limit: 60
Enrollment Preferences: Students who have officially declared a major that requires Math 250.
Expected Class Size: 40
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: In this course, students will engage in both quantitative and formal reasoning.
Attributes: COGS Related Courses

Fall 2024
LEC Section: 01 MWF 10:00 am - 10:50 am Christina Athanasouli
LEC Section: 02 MWF 11:00 am - 11:50 am Christina Athanasouli

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Ivo Terek
LEC Section: 02 MWF 10:00 am - 10:50 am Ivo Terek

MATH 309 (F)(S) Differential Equations (QFR)
Ordinary differential equations (ODEs) frequently arise as models of phenomena in the natural and social sciences. This course presents core ideas of ODEs from an applied standpoint. Topics covered early in the course may include numerical solutions, separation of variables, integrating factors, and constant coefficient linear equations. Later, we will focus on nonlinear ODEs, for which it is usually impossible to find analytical solutions. Tools from dynamical systems will be introduced to allow us to obtain information about the behavior of the ODEs without explicitly knowing the solution.

Requirements/Evaluation: quizzes/exams, problem sets, participation
Prerequisites: MATH 150/151 and MATH 250
Enrollment Limit: 40
Enrollment Preferences: discretion of the instructor
Expected Class Size: 30
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: 300-level mathematics course

Fall 2024
MATH 313 (S) Introduction to Number Theory (WS) (QFR)
The study of numbers dates back thousands of years, and is fundamental in mathematics. In this course, we will investigate both classical and modern questions about numbers. In particular, we will explore the integers, and examine issues involving primes, divisibility, and congruences. We will also look at the ideas of number and prime in more general settings, and consider fascinating questions that are simple to understand, but can be quite difficult to answer. This course will include a significant focus on mathematical proof writing and problem solving skills. This includes writing clear and rigorous mathematical proofs, clearly explaining mathematical ideas verbally and in writing, determining how to approach certain types of problems, looking for patterns and making conjectures, and asking good questions about the implications of certain ideas and theorems.

Requirements/Evaluation: Problem sets, project, and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 19
Enrollment Preferences: If course is over-enrolled, enrollment preference will be based on answers to a questionnaire. Some preference will be given to students who have not yet had Math 355.
Expected Class Size: 19
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (WS) (QFR)
Writing Skills Notes: Students will complete weekly problem sets, with a strong emphasis on proof writing, as well as 2 5-10 page papers/projects. There will be feedback given on mathematical writing as well as accuracy, and discussion time during class on writing in math.
Quantitative/Formal Reasoning Notes: This course requires working with various number systems, performing explicit computations, and proving mathematical results using logical reasoning practices.

Spring 2025
LEC Section: 01    TR 9:55 am - 11:10 am     Allison Pacelli

MATH 326 (F) Differential Geometry (QFR)
Differential Geometry is the study of curvature. In turn, curvature is the heart of geometry. The goal of this course is to start the study of curvature, concentrating on the curvature of curves and of surfaces, leading to the deep Gauss-Bonnet Theorem, which links curvature with topology.

Class Format: lecture
Requirements/Evaluation: Evaluation will be based primarily on problem sets, midterms and a final exam
Prerequisites: MATH 250
Enrollment Limit: 30
Enrollment Preferences: Preference to mathematics majors.
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: It is a mathematics upper level course.

Fall 2024
LEC Section: 01    MWF 11:00 am - 11:50 am     Ivo Terek

MATH 331 (F) The little Questions (QFR)
Using math competitions such as the Putnam Exam as a springboard, in this class we follow the dictum of the Ross Program and "think deeply of
simple things”. The two main goals of this course are to prepare students for competitive math competitions, and to get a sense of the mathematical landscape encompassing elementary number theory, combinatorics, graph theory, and group theory (among others). While elementary frequently is not synonymous with easy, we will see many beautiful proofs and “a-ha” moments in the course of our investigations. Students will be encouraged to explore these topics at levels compatible with their backgrounds.

Requirements/Evaluation: homework, classwork, and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: members or alternates of the Putnam team, Mathematics, Physics or Computer Science majors
Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Unit Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/331Fa24/
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is an upper level math course where students learn advanced material and solve challenging problems.

Fall 2024
LEC Section: 01 MWF 10:00 am - 10:50 am Steven J. Miller

MATH 334 (S) Graph Theory (QFR)
A graph is a collection of vertices, joined together by edges. In this course, we will study the sorts of structures that can be encoded in graphs, along with the properties of those graphs. We’ll learn about such classes of graphs as multi-partite, planar, and perfect graphs, and will see applications to such optimization problems as minimum colorings of graphs, maximum matchings in graphs, and network flows.
Requirements/Evaluation: problem sets, exams, and a short final project
Prerequisites: MATH 200 or MATH 250
Enrollment Limit: 30
Enrollment Preferences: Math majors
Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course involves the writing of mathematical proofs.

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Ralph E. Morrison

MATH 338 (F) Intermediate Logic (QFR)
Cross-listings: PHIL 338
Secondary Cross-listing
In this course, we will begin with an in-depth study of the theory of first-order logic. We will first get clear on the formal semantics of first-order logic and various ways of thinking about formal proof: natural deduction systems, semantic tableaux, axiomatic systems and sequent calculi. Our main goal will be to prove things about this logical system rather than to use this system to think about ordinary language arguments. In this way the goal of the course is significantly different from that of Logic and Language (PHIL 203). Students who have take PHIL 203 will have a good background for this class, but students who are generally comfortable with formal systems need not have taken PHIL 203. We will prove soundness and completeness, compactness, the Lowenheim-Skolem theorems, undecidability and other important results about first-order logic. As we go through these results, we will think about the philosophical implications of first-order logic. From there, we will look at extensions of and/or alternatives to first-order logic. Possible additional topics would include: modal logic, the theory of counterfactuals, alternative representations of conditionals, the use of logic in the foundations of arithmetic and Godel's Incompleteness theorems. Student interest will be taken into consideration in deciding what additional topics to cover.
**Requirements/Evaluation:** problem sets and exams  
**Prerequisites:** some class in which student has studied formal reasoning  
**Enrollment Limit:** 20  
**Enrollment Preferences:** Philosophy majors; juniors and seniors  
**Expected Class Size:** 15  
**Grading:** yes pass/fail option, yes fifth course option  
**Distributions:** (D3)  
This course is cross-listed and the prefixes carry the following divisional credit:  
PHIL 338(D2) MATH 338(D3)  
**Quantitative/Formal Reasoning Notes:** This is a class in Formal Logic. PHIL 203 satisfies the QFR requirement. If anything, this class will be significantly more formal.  
**Attributes:** PHIL Contemp Metaphysics + Epistemology Courses  

Fall 2024  
SEM Section: 01  
TF 2:35 pm - 3:50 pm  
Keith E. McPartland

**MATH 341 (F)(S) Probability** (QFR)  
**Cross-listings:** STAT 341  
**Primary Cross-listing**

The historical roots of probability lie in the study of games of chance. Modern probability, however, is a mathematical discipline that has wide applications in a myriad of other mathematical and physical sciences. Drawing on classical gaming examples for motivation, this course will present axiomatic and mathematical aspects of probability. Included will be discussions of random variables (both discrete and continuous), distribution and expectation, independence, laws of large numbers, and the well-known Central Limit Theorem. Many interesting and important applications will also be presented, including some from classical Poisson processes, random walks and Markov Chains.  
**Requirements/Evaluation:** homework, classwork, and exams  
**Prerequisites:** MATH 150 and MATH 250 or permission of the instructor  
**Enrollment Limit:** 50  
**Enrollment Preferences:** Priority will be given to Mathematics majors and to Statistics Majors.  
**Expected Class Size:** 20  
**Grading:** yes pass/fail option, yes fifth course option  
**Distributions:** (D3)  
This course is cross-listed and the prefixes carry the following divisional credit:  
STAT 341(D3) MATH 341(D3)  
**Quantitative/Formal Reasoning Notes:** This is a 300-level Math/Stat course.  

Fall 2024  
LEC Section: 01  
MWF 12:00 pm - 12:50 pm  
Mihai Stoiciu  
Spring 2025  
LEC Section: 01  
TR 9:55 am - 11:10 am  
Steven J. Miller

**MATH 345 (S) Introduction to Numerical Analysis** (QFR)  
Numerical analysis is the study of algorithms that use numerical approximation to solve problems which arise in scientific applications. This course provides an introduction to the theory, development, and analysis of algorithms for obtaining numerical solutions. We will also use mathematical software to facilitate numerical experimentation. Topics discussed in the course include: Error Analysis and Convergence Rates of Algorithms; Root Finding for Nonlinear Equations; Approximating Functions; Numerical Differentiation and Integration; Numerical Solutions of Ordinary Differential Equations; Iterative Methods for Solving Linear Systems.
Requirements/Evaluation: Evaluation will be based on homework, projects, and exams.
Prerequisites: Math 250 and Math 150/151
Enrollment Limit: 30
Enrollment Preferences: Mathematics and Statistics majors.
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced mathematics class that will cover the fundamental ideas of Numerical Analysis. The students will study in depths various algorithms that provide numerical solutions to various questions in science.

Spring 2025
LEC Section: 01 MWF 11:00 am - 11:50 am Christina Athanasouli

MATH 350 (F)(S) Real Analysis (QFR)
Why is the product of two negative numbers positive? Why do we depict the real numbers as a line? Why is this line continuous, and what do we mean when we say that? Perhaps most fundamentally, what is a real number? Real analysis addresses such questions, delving into the structure of real numbers and functions of them. Along the way we'll discuss sequences and limits, series, completeness, compactness, derivatives and integrals, and metric spaces. Results covered will include the Cantor-Schroeder-Bernstein theorem, the monotone convergence theorem, the Bolzano-Weierstrass theorem, the Cauchy criterion, Dirichlet's and Riemann's rearrangement theorem, the Heine-Borel theorem, the intermediate value theorem, and many others. This course is excellent preparation for graduate studies in mathematics, statistics, and economics.

Requirements/Evaluation: Problem sets and exams.
Prerequisites: MATH 250 or permission of instructor.
Enrollment Limit: 40
Enrollment Preferences: Juniors and Seniors.
Expected Class Size: 25
Grading: no pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is an advanced mathematics course.

Fall 2024
LEC Section: 01 MR 2:35 pm - 3:50 pm Leo Goldmakher

Spring 2025
LEC Section: 01 TR 11:20 am - 12:35 pm Cesar E. Silva

MATH 351 (S) Applied Real Analysis (QFR)
This course is designed to introduce students to the underpinnings of real analysis, primarily in the context of Fourier series. By the end of the semester people will be comfortable making epsilon and delta type arguments. These types of arguments are one of the main pillars of modern mathematics. In a similar way, Fourier series and their generalizations are one of the pillars of the modern digital world.

Requirements/Evaluation: homework, classwork, and exams
Prerequisites: MATH 150 and MATH 250 or permission of the instructor.
Enrollment Limit: 50
Enrollment Preferences: Seniors
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: Math

Spring 2025
LEC Section: 01  MR 2:35 pm - 3:50 pm  Palak Arora

MATH 355  (F)(S)  Abstract Algebra  (QFR)
Algebra gives us tools to solve equations. The integers, the rationals, and the real numbers have special properties which make algebra work according to the circumstances. In this course, we generalize algebraic processes and the sets upon which they operate in order to better understand, theoretically, when equations can and cannot be solved. We define and study abstract algebraic structures such as groups, rings, and fields, as well as the concepts of factor group, quotient ring, homomorphism, isomorphism, and various types of field extensions. This course introduces students to abstract rigorous mathematics.

Requirements/Evaluation: Problem sets and exams
Prerequisites: MATH 250 or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: Students who have officially declared a major that requires Math 355.
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: 300-level math course

Fall 2024
LEC Section: 01  TR 8:30 am - 9:45 am  Allison Pacelli
LEC Section: 02  TR 9:55 am - 11:10 am  Allison Pacelli

Spring 2025
LEC Section: 01  MWF 11:00 am - 11:50 am  Mihai Stoiciu
LEC Section: 02  MWF 12:00 pm - 12:50 pm  Mihai Stoiciu

MATH 361  (F)  Theory of Computation  (QFR)
Cross-listings: CSCI 361
Secondary Cross-listing
This course introduces a formal framework for investigating both the computability and complexity of problems. We study several models of computation including finite automata, regular languages, context-free grammars, and Turing machines. These models provide a mathematical basis for the study of computability theory--the examination of what problems can be solved and what problems cannot be solved--and the study of complexity theory--the examination of how efficiently problems can be solved. Topics include the halting problem and the P versus NP problem.

Requirements/Evaluation: weekly problem sets and one or more exams
Prerequisites: CSCI 256 or both a 300-level MATH course and permission of instructor
Enrollment Limit: 24
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
MATH 361(D3) CSCI 361(D3)

Quantitative/Formal Reasoning Notes: This course include regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.
MATH 374  (F)  Topology  (QFR)
In Real Analysis you learned about metric spaces---any set of objects endowed with a way of measuring distance---and the topology of sets in such spaces (open, closed, bounded, etc). In this course we flip this on its head: we explore how to develop analysis (limits, continuity, etc) in spaces where the topology is known but the metric is not. This will lead us to a bizarre and fascinating version of geometry in which we cannot distinguish between shapes that can be continuously deformed into one another. Not only does this theory turn out to be beautiful in the abstract, it plays an important role in math, physics, and data analysis. This course is excellent preparation for graduate programs in mathematics.

Requirements/Evaluation: Problem sets, exams, an expository essay.
Prerequisites: MATH 350 or 351; not open to students who have taken MATH 323. If you didn't cover metric spaces in real analysis, that's OK!
Enrollment Limit: 30
Enrollment Preferences: Juniors and seniors
Expected Class Size: 20
Grading: no pass/fail option, yes fifth course option
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: It's math.

MATH 382  (S)  Fourier Analysis  (QFR)
Fourier analysis is the study of waves and frequencies. More precisely, the goal of Fourier analysis is to decompose a complicated function into a simple combination of pure waves, thereby gleaning insight into the behavior of the function itself. It's difficult to overstate the impact of this branch of mathematics; it is foundational throughout theoretical mathematics (e.g., to study the distribution of prime numbers), applied mathematics (e.g., to solve differential equations), physics (e.g., to study properties of light and sound), computer science (e.g., to compute with large integers and matrices), audio engineering (e.g., to pitch-correcting algorithms), medical science (e.g., throughout radiology), etc. The goal of this course is to cover the basic theory (fourier series, the fourier transform, the fast fourier transform) and explore a number of applications, including Dirichlet's theorem on primes in arithmetic progressions, the isoperimetric inequality, the heat equation, and Heisenberg's uncertainty principle.

Class Format: Every week, each student will either give a lecture (based on provided readings) or explain solutions to selected problems.
Requirements/Evaluation: Evaluation will be based on lectures and presentation of problem solutions.
Prerequisites: MATH 350 or MATH 351 or permission of instructor.
Enrollment Limit: 10
Enrollment Preferences: By lottery.
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: It's math!
MATH 389  (S)  Advanced Analysis  (WS) (QFR)
This course further develops and explores topics and concepts from real analysis, with special emphasis on introducing students to subject matter and techniques that are useful for graduate study in mathematics or an allied field. Material will be drawn, based on student interest, from many areas, including analytic number theory, Fourier series and harmonic analysis, generating functions, differential equations and special functions, integral operators, equidistribution theory and probability, random matrix theory and probabilistic methods. This will be an intense, fast paced class which will give a flavor for graduate school. In addition to standard homework problems, students will also write reviews for MathSciNet, referee papers for journals, write programs in SAGE or Mathematica to investigate and conjecture, and read classic and current research papers.

Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Prerequisites: MATH 350 or 351 and one additional 300-level MATH course, or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: students interested in graduate school in mathematics or an allied discipline
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/389/
Distributions: (D3)  (WS) (QFR)
Writing Skills Notes: Students will improve and expand their writing skills by taking course material as a starting point and writing chapters for a book under contract with the American Mathematical Society. This will involve numerous iterations of the content, with feedback both from the professor and from an editor.
Quantitative/Formal Reasoning Notes: This is a post-core 300 level math class.

Spring 2025
LEC Section: 01    TR 11:20 am - 12:35 pm     Steven J. Miller

MATH 403  (F)  Measure and Ergodic Theory  (QFR)
An introduction to measure theory and ergodic theory. Measure theory is a generalization of the notion of length and area, and has been used in the study of stochastic (probabilistic) systems. The course covers the construction of Lebesque and Borel measures, measurable functions, and Lebesque integration. Ergodic theory studies the probabilistic behavior of dynamical systems as they evolve through time, and is based on measure theory. The course will cover basic notions, such as ergodic transformations, weak mixing, mixing, Bernoulli transformations, and transformations admitting and not admitting an invariant measure. There will be an emphasis on specific examples such as group rotations, the binary odometer transformations, and rank-one constructions. The Ergodic Theorem will also be covered, and will be used to illustrate notions and theorems from measure theory.

Requirements/Evaluation: Homework and exams
Prerequisites: MATH 350 or MATH 351 or permission of instructor
Enrollment Limit: 25
Enrollment Preferences: Mathematics majors
Expected Class Size: 15-20
Grading: yes pass/fail option, yes fifth course option
Unit Notes: senior major course
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: It is an advanced mathematics course.

Fall 2024
LEC Section: 01    MR 2:35 pm - 3:50 pm     Cesar E. Silva

MATH 408  (F)  L-Functions and Sphere Packing  (WS) (QFR)
Optimal packing problems arise in many important problems, and have been a source of excellent mathematics for centuries. The Kepler Problem
(what is the most efficient way to pack balls in three-space) is a good example. The original formulation has been used in such diverse areas as stacking cannonbells on battleships to grocers preparing fruit displays, and its generalizations allow the creation of powerful error detection and correction codes. While the solution of the Kepler Problem is now known, the higher dimensional version is very much open. There has been remarkable progress in the last few years, with number theory playing a key role in these results. We will develop sufficient background material to understand many of these problems and the current state of the field. Pre-requisites are real analysis.

Requirements/Evaluation: Class participation, homework, exams and participation in writing a textbook on the material. Each student will be responsible for working on a chapter of a book based on this material. In addition to obtaining critical writing feedback from myself and my co-author (who is a world expert in the subject), depending on timing we will also be able to share comments from an editor of a major publishing house or a referee. Chapters can range from short snapshots of a subject, on the order of 5 pages, to longer technical derivations of perhaps 10-30 pages.

Prerequisites: Math 350 or 351

Enrollment Limit: 40

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (WS) (QFR)

Writing Skills Notes: Students will improve and expand their writing skills by taking course material as a starting point and writing chapters for a book under contract with the American Mathematical Society. This will involve numerous iterations of the content, with feedback both from the professor and from an editor.

Quantitative/Formal Reasoning Notes: This is a 400 level math class

Fall 2024

LEC Section: 01  MWF 11:00 am - 11:50 am  Steven J. Miller

MATH 411  (S)  Commutative Algebra  (QFR)

Commutative Algebra is an essential area of mathematics that provides indispensable tools to many areas, including Number Theory and Algebraic Geometry. This course will introduce you to the fundamental concepts for the study of commutative rings, with a special focus on the notion of "prime ideals," and how they generalize the well-known notion of primality in the set of integers. Commutative algebra has applications ranging from algebraic geometry to coding theory. For example, one can use commutative algebra to create error correcting codes. It is perhaps most often used, however, to study curves and surfaces in different spaces. To understand these structures, one must study polynomial rings over fields. This course will be an introduction to commutative algebra. Possible topics include polynomial rings, localizations, primary decomposition, completions, and modules.

Requirements/Evaluation: homework and exams

Prerequisites: MATH 355 or permission of instructor

Enrollment Limit: 25

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is a 400-level math course

Spring 2025

LEC Section: 01  MWF 9:00 am - 9:50 am  Susan R. Loepp

MATH 412  (S)  Mathematical Biology  (QFR)

Cross-listings: BIOL 420

Primary Cross-listing

This course will provide an introduction to the many ways in which mathematics can be used to understand, analyze, and predict biological dynamics. We will learn how to construct mathematical models that capture essential properties of biological processes while maintaining analytic tractability.
Analytic techniques, such as stability and bifurcation analysis, will be introduced in the context of both continuous and discrete time models. Additionally, students will couple these analytic tools with numerical simulation to gain a more global picture of the biological dynamics. Possible biological applications may include, but are not limited to, single and multi-species population dynamics, neural and biological oscillators, tumor cell growth, and infectious disease dynamics.

**Requirements/Evaluation:** problem sets, quizzes/exams, participation, final project and paper

**Prerequisites:** MATH 250 and MATH 309, or permission of instructor

**Enrollment Limit:** 30

**Enrollment Preferences:** preference for senior math/stats major and also based on an interest statement

**Expected Class Size:** 30

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
MATH 412(D3) BIOL 420(D3)

**Quantitative/Formal Reasoning Notes:** The course will introduce methods for developing and analyzing mathematical models.

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Spring 2025

LEC Section: 01   TR 9:55 am - 11:10 am   Julie C. Blackwood

**MATH 426 (F) Differential Topology  (QFR)**

Differential topology marries the rubber-like deformations of topology with the computational exactness of calculus. This sub field of mathematics asks and answers questions like "Can you take an integral on the surface of doughnut?" and includes far-reaching applications in relativity and robotics. This tutorial will provide an elementary and intuitive introduction to differential topology. We will begin with the definition of a manifold and end with a generalized understanding of Stokes Theorem.

**Requirements/Evaluation:** weekly homework and exams, and possibly student presentations

**Prerequisites:** MATH 350 (students who have not taken MATH 350 may enroll only with permission of the instructor)

**Enrollment Limit:** 30

**Enrollment Preferences:** mathematics seniors, mathematics majors

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** There will be weekly math problem sets.

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Spring 2024

LEC Section: 01   MWF 9:00 am - 9:50 am   Ivo Terek

**MATH 453 (S) Partial Differential Equations  (QFR)**

In this course, we further explore the world of differential equations. Mainly, we cover topics in partial differential equations. Partial Differential Equations (PDEs) are fundamental to the modeling of many natural phenomena, arising in many fields, including fluid mechanics, heat and mass transfer, electromagnetic theory, finance, elasticity, and more. The goals of this course are to discuss the following topics: classification of PDEs in terms of order, linearity and homogeneity; physical interpretation of canonical PDEs; solution techniques, including separation of variables, series solutions, integral transforms, and the method of characteristics.

**Requirements/Evaluation:** Evaluation will be based on homework, projects, and exams.

**Prerequisites:** MATH 150-151; MATH/PHYS 210 or MATH 309

**Enrollment Limit:** 20

**Enrollment Preferences:** Mathematics and Physics majors.

**Expected Class Size:** 15
Quantitative/Formal Reasoning Notes: This is an advanced mathematics class dedicated to the study of partial differential equations (PDEs). These equations are the most important mathematical tools for the study of complex physical phenomena such as waves and fluids (including both air and water), heat transfer, electromagnetism, and finance.

Spring 2025
LEC Section: 01 TR 11:20 am - 12:35 pm Bhagya Athukorallage

PHIL 203 (S) Introductory Logic (QFR)
Logic is the study of reasoning and argument. More particularly, it concerns itself with the differences between good and bad reasoning, between strong and weak arguments. This course is an introduction to the precise characterization of good logical reasoning. We will learn a to a formal language, Monadic First-Order Logic, designed to cleanly represent good inference patterns. Learning this language will primarily involve learning two skills: (i) translation between sentences of English and formulas of the logical language, and (ii) proving the validity of logical arguments using a system of natural deduction. No prior mathematical/logical/formal experience is assumed for this course.

Requirements/Evaluation: A midterm, a final, frequent problem sets.
Prerequisites: none
Enrollment Limit: 40
Enrollment Preferences: Preference given to philosophy majors.
Expected Class Size: 40
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: This course teaches two formal languages of logic: sentential logic and predicate logic.

Attributes: Linguistics PHIL Contemp Metaphysics + Epistemology Courses

Spring 2025
LEC Section: 01 MR 1:10 pm - 2:25 pm Christian De Leon

PHIL 221 (F) Introduction to Formal Linguistics (QFR)
Cross-listings: COGS 224
Secondary Cross-listing
The sentence "Every cookie is chocolate chip and three of them are oatmeal raisin" is a perfectly grammatical sentence of English, but it's self-contradictory. What does it take to realize this fact? One must grasp the meanings of the various parts of the sentence. In particular, one must grasp that "three of them" picks out a subset of the group picked out by "every cookie", and that there’s no such thing as a cookie that is both chocolate chip and oatmeal raisin. There two ways to understand "Many students took every class". According to one, there is a single group of students that had their hands extremely full this semester. According to the other, every class was well-populated, potentially by different groups. The reason for this is that there are two underlying structures that the original sentence can realize. This course serves as an introduction to formal methods in the scientific study of language. Our goal will be to characterize phenomena like those above with logical and mathematical precision. The focus will be on model-theoretic semantics, the sub-field of linguistics that studies meanings. Along the way we will discuss principles of syntax, the sub-field that studies sentence structures, and pragmatics, the sub-field that studies inferences of non-literal content. This is a formal course, but no prior logical or mathematical background will be expected. Starting from scratch, students will learn the building blocks of current-day linguistic research. This introduction will be of use to students interested in language from a variety of perspectives, including philosophy, cognitive science, and computer science.

Requirements/Evaluation: Weekly problem sets, plus a final project (paper/presentation/other type, to be discussed with instructor)
Prerequisites: No prerequisites
Enrollment Limit: 20
Enrollment Preferences: Preference given to seniors and philosophy/cognitive science majors.
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHIL 221(D2) COGS 224(D2)

Quantitative/Formal Reasoning Notes: This course teaches the fundamentals of the formal analysis of language. Students will learn to provide translation schemes from English to a logical language (typed lambda calculus).

Attributes: COGS Interdepartmental Electives  COGS Related Courses  Linguistics  PHIL Contemp Metaphysics + Epistemology Courses

Fall 2024
LEC Section: 01  MR 1:10 pm - 2:25 pm  Christian De Leon

PHIL 338  (F)  Intermediate Logic  (QFR)

Cross-listings: MATH 338

Primary Cross-listing

In this course, we will begin with an in-depth study of the theory of first-order logic. We will first get clear on the formal semantics of first-order logic and various ways of thinking about formal proof: natural deduction systems, semantic tableaux, axiomatic systems and sequent calculi. Our main goal will be to prove things about this logical system rather than to use this system to think about ordinary language arguments. In this way the goal of the course is significantly different from that of Logic and Language (PHIL 203). Students who have take PHIL 203 will have a good background for this class, but students who are generally comfortable with formal systems need not have taken PHIL 203. We will prove soundness and completeness, compactness, the Lowenheim-Skolem theorems, undecidability and other important results about first-order logic. As we go through these results, we will think about the philosophical implications of first-order logic. From there, we will look at extensions of and/or alternatives to first-order logic. Possible additional topics would include: modal logic, the theory of counterfactuals, alternative representations of conditionals, the use of logic in the foundations of arithmetic and Godel's Incompleteness theorems. Student interest will be taken into consideration in deciding what additional topics to cover.

Requirements/Evaluation: problem sets and exams
Prerequisites: some class in which student has studied formal reasoning
Enrollment Limit: 20
Enrollment Preferences: Philosophy majors; juniors and seniors
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHIL 338(D2) MATH 338(D3)

Quantitative/Formal Reasoning Notes: This is a class in Formal Logic. PHIL 203 satisfies the QFR requirement. If anything, this class will be significantly more formal.

Attributes: PHIL Contemp Metaphysics + Epistemology Courses

Fall 2024
SEM Section: 01  TF 2:35 pm - 3:50 pm  Keith E. McPartland

PHYS 108  (S)  Energy Science and Technology  (QFR)

Cross-listings: ENVI 108

Primary Cross-listing

Energy use has skyrocketed in the United States and elsewhere in the world, causing significant economic and political shifts, as well as concerns for the environment. This course will address the physics and technology of energy generation, consumption, and conservation. It will cover a wide range
of energy sources, including fossil fuels, hydropower, solar energy, wind energy, and nuclear energy. We will discuss energy use in transportation, manufacturing, building heating and lighting, and energy storage. Students will learn to compare the efficiencies and environmental impacts of various energy sources and uses.

**Class Format:** Two meetings per week. Some weeks that means two lectures. Other weeks, that means one lecture plus one lab, with the class divided between two lab sections.

**Requirements/Evaluation:** weekly assignments, two hour tests, and a final project culminating in an oral presentation to the class and a 10-page paper; all of these will be substantially quantitative

**Prerequisites:** high school physics, high school chemistry, and mathematics at the level of MATH 130

**Enrollment Limit:** 10 per lab

**Enrollment Preferences:** non-physics majors

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Attributes:** ENVI Natural World Electives

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**PHYS 131 (F) Introduction to Mechanics (QFR)**

We focus first on the Newtonian mechanics of point particles: the relationship between velocity, acceleration, and position; the puzzle of circular motion; forces, Newton's laws, and gravitation; energy and momentum; and the physics of vibrations. Then we turn to the basic properties of waves, such as interference and refraction, as exemplified by sound and light waves. We also study the optics of lenses, mirrors and the human eye. This course is not intended for students who have successfully completed an AP physics course in high school.

**Requirements/Evaluation:** exams, labs, and weekly problem sets, all of which have a substantial quantitative component

**Prerequisites:** MATH 130; students who scored 4 or 5 on an AP physics exam, or 6 or 7 on the IB Physics HL exam may not take this course and are encouraged to take PHYS 141 instead

**Enrollment Limit:** 24 per lab

**Enrollment Preferences:** seniority

**Expected Class Size:** 60

**Grading:** yes pass/fail option, yes fifth course option

**Unit Notes:** PHYS 131 can lead to either PHYS 132 (for students wanting a one-year survey of physics) or PHYS 142 (for students considering a Physics or Astrophysics major)

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This class will have weekly problem sets requiring substantial quantitative reasoning
This course is intended as the second half of a one-year survey of physics with some emphasis on applications to medicine. In the first part of the semester we will focus on electromagnetic phenomena. We will introduce the concept of electric and magnetic fields and study in detail the way in which electrical circuits and circuit elements work. The deep connection between electric and magnetic phenomena is highlighted with a discussion of Faraday's Law of Induction. Following our introduction to electromagnetism we will discuss some of the most central topics in twentieth-century physics, including Einstein's theory of special relativity and some aspects of quantum theory. We will end with a treatment of nuclear physics, radioactivity, and uses of radiation.

Class Format: lecture three hours per week, laboratory three hours approximately every other week, and conference section 1 hour approximately every other week

Requirements/Evaluation: weekly problem sets, labs, quizzes and exams

Prerequisites: PHYS 131 or 141 or permission of instructor, and MATH 130 (formerly 103)

Enrollment Limit: 22 per lab

Enrollment Preferences: sophomores

Expected Class Size: 60

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Significant homework, exams, quizzes requiring mathematical and physical reasoning.

Spring 2025

LEC Section: 01  MWF 11:00 am - 11:50 am  Catherine Kealhofer
LAB Section: 02  M 1:00 pm - 4:00 pm  Catherine Kealhofer
LAB Section: 03  T 1:00 pm - 4:00 pm  Catherine Kealhofer

PHYS 141 (F) Mechanics and Waves (QFR)

This is the typical first course for a prospective physics major. It covers most of the same topics as PHYS 131, but with a higher level of mathematical sophistication. It is intended for students with solid backgrounds in the sciences, either from high school or college, who are comfortable with basic calculus.

Class Format: lecture, three hours per week; laboratory, three hours approximately every other week; conference section, 1.5 hours approximately every other week

Requirements/Evaluation: weekly problem sets, labs, two 1-hour exams, and a final exam, all of which have a substantial quantitative component

Prerequisites: High school physics (strongly recommended) and MATH 130 or equivalent placement, or permission of the instructor. High school physics at the AP, IB, or equivalent level is neither required nor expected.

Enrollment Limit: 24 per lab

Enrollment Preferences: first-year students and science majors

Expected Class Size: 40

Grading: yes pass/fail option, yes fifth course option

Unit Notes: PHYS 141 can lead to either PHYS 132 (for students wanting a one-year survey of physics) or PHYS 142 (for students considering a Physics or Astrophysics major)

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course consists of lectures, problem-solving conferences, lab exercises, problem sets and exams, all of which have a substantial quantitative component.

Fall 2024

LEC Section: 01  MWF 11:00 am - 11:50 am  Betul Pamuk
LAB Section: 02  M 1:00 pm - 4:00 pm  Betul Pamuk
LAB Section: 03  T 1:00 pm - 4:00 pm  Betul Pamuk
Newtonian Mechanics, spectacular as it is in describing planetary motion and a wide range of other phenomena, only hints at the richness of behaviors seen in the universe. Special relativity, which extends physics into the realm of high speeds and high energies, requires us to rethink our basic notions of space and time. Quantum mechanics successfully describes atoms, molecules, and solids while at the same time calling into question our expectation of what can be predicted by a physical theory. Statistical physics reveals new behaviors that emerge when many particles are present in a system. This course will survey ideas from each of these three arenas, and can serve either as a terminal course for those seeking to complete a year of physics or as the basis for future advanced study of these topics.

**Class Format**: lecture, three hours weekly; laboratory, 2-3 hours most weeks, alternating between 'hands-on' sessions and problem-solving/discussion sessions

**Requirements/Evaluation**: weekly homework, labs, two hour tests, and a final exam, all of which have a substantial quantitative component

**Prerequisites**: PHYS 141 and MATH 130, or equivalent; PHYS 131 may substitute for PHYS 141 with the permission of instructor; students may not take both PHYS 142 and PHYS 151

**Enrollment Limit**: 14/L

**Enrollment Preferences**: first-year students

**Expected Class Size**: 30

**Grading**: yes pass/fail option, yes fifth course option

**Distributions**: (D3) (QFR)

**Quantitative/Formal Reasoning Notes**: Heavily problem-solving focused, involving algebraic manipulations, single-variable calculus, generating and reading graphs, etc.

Spring 2025

LEC Section: 01  MWF 11:00 am - 11:50 am     Graham K. Giovanetti
LAB Section: 02  M 1:00 pm - 4:00 pm     Graham K. Giovanetti
LAB Section: 03  T 1:00 pm - 4:00 pm     Graham K. Giovanetti

**PHYS 151 (F) Seminar in Modern Physics** (QFR)

Newtonian Mechanics, spectacular as it is in describing planetary motion and a wide range of other phenomena, only hints at the richness of behaviors seen in the universe. Special relativity has extended physics into the realm of high speeds and high energies and requires us to rethink our basic notions of space and time. Quantum mechanics successfully describes atoms, molecules, and solids while at the same time calling into question our notions of what can be predicted by a physical theory. Statistical physics reveals new behaviors that emerge when many particles are present in a system. This course covers the same core material as PHYS 142 but in a small seminar format for students with strong prior preparation in physics.

**Class Format**: lecture/discussions plus one 3-hour lab per week

**Requirements/Evaluation**: class participation, weekly lab assignments, weekly problem sets, exams

**Prerequisites**: placement by the department (see "advanced placement" section in the description about the department). Students may take either PHYS 142 or PHYS 151 but not both

**Enrollment Limit**: 18

**Enrollment Preferences**: first-years

**Expected Class Size**: 16

**Grading**: yes pass/fail option, yes fifth course option

**Unit Notes**: this is a small seminar designed for first-year students who have placed out of PHYS 141

**Distributions**: (D3) (QFR)

**Quantitative/Formal Reasoning Notes**: all assignments in the course have a substantial quantitative component

Fall 2024

LEC Section: 01  MWF 11:00 am - 12:15 pm     Catherine Kealhofer
LAB Section: 02  T 1:00 pm - 4:00 pm     Catherine Kealhofer
PHYS 201 (F) Electricity and Magnetism (QFR)
The classical theory of electricity and magnetism is very rich yet it can be written in a remarkably succinct form using Maxwell's equations. This course is an introduction to electricity and magnetism and their mathematical description, connecting electric and magnetic phenomena via the special theory of relativity. Topics include electrostatics, magnetic fields, electromagnetic induction, DC and AC circuits, and the electromagnetic properties of matter. The laboratory component of the course is an introduction to electronics where students will develop skills in building and debugging electrical circuits.

Class Format: lecture, three hours per week; laboratory, three hours per week
Requirements/Evaluation: problem sets, labs/conference section assignments, two midterms, and a final exam, all of which have a substantial quantitative component
Prerequisites: PHYS 142 OR 151; MATH 150 or 151; with a preference for MATH 151
Enrollment Limit: 10 per lab
Enrollment Preferences: prospective physics majors, then by seniority
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course involves significant problem-solving and mathematical analysis of phenomena using calculus, numerical methods, and other quantitative tools.

Fall 2024
LEC Section: 01 MWF 10:00 am - 10:50 am David R. Tucker-Smith
LAB Section: 02 W 1:00 pm - 4:00 pm David R. Tucker-Smith
LAB Section: 03 R 1:00 pm - 4:00 pm David R. Tucker-Smith

PHYS 202 (S) Vibrations, Waves and Optics (QFR)
Waves and oscillations characterize many different physical systems, including vibrating strings and springs, waves at the beach, or those that we hear as sound or see as light. Quantum mechanics describes particles with wave functions, and gravitational waves distort the very fabric of the universe. Despite these diverse settings, waves exhibit several common characteristics, so understanding of a few simple systems can provide insight into a wide array of phenomena. In this course we begin with the study of oscillations of simple systems with only a few degrees of freedom. We then move on to study transverse and longitudinal waves in continuous media in order to gain a general description of wave behavior. We conclude with a focus on electromagnetic waves and in particular on optical examples of wave phenomena such as interference, diffraction, and lasers. Throughout the course we will introduce and develop mathematical tools which will continue to see use in higher-level physics.

Class Format: lecture, three hours per week; laboratory, three hours per week
Requirements/Evaluation: problem sets, labs, midterm examinations, and a final exam, all of which have a substantial quantitative component
Prerequisites: PHYS 201; co-requisite: PHYS/MATH 210 or MATH 309 or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: sophomores
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: Weekly problem sets and laboratories which develop and use quantitative skills.

Spring 2025
LEC Section: 01 MWF 10:00 am - 10:50 am Katharine E. Jensen
LAB Section: 02 W 1:00 pm - 4:00 pm Frederick W. Strauch
LAB Section: 03 R 1:00 pm - 4:00 pm Frederick W. Strauch
PHYS 210 (S) Mathematical Methods for Scientists (QFR)

Cross-listings: MATH 210

Primary Cross-listing

This course covers a variety of mathematical methods used in the sciences, focusing particularly on the solution of ordinary and partial differential equations. In addition to calling attention to certain special equations that arise frequently in the study of waves and diffusion, we develop general techniques such as looking for series solutions and, in the case of nonlinear equations, using phase portraits and linearizing around fixed points. We study some simple numerical techniques for solving differential equations. An optional session in Mathematica will be offered for students who are not already familiar with this computational tool.

Class Format: three hours per week

Requirements/Evaluation: several exams and weekly problem sets, all of which have a substantial quantitative component

Prerequisites: MATH 150 or 151 and familiarity with Newtonian mechanics at the level of PHYS 131

Enrollment Limit: 50

Enrollment Preferences: sophomores and juniors

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHYS 210(D3) MATH 210(D3)

Quantitative/Formal Reasoning Notes: This course will have weekly problem sets using advanced calculus methods

Spring 2025
LEC Section: 01 TR 9:55 am - 11:10 am Frederick W. Strauch

PHYS 234 (S) Introduction to Materials Science (QFR)

Cross-listings: GEOS 234

Primary Cross-listing

Materials Science is the study of how the microscopic structure of materials—whether steel, carbon fiber, glass, wood, plastic, or mayonnaise—determines their macroscopic mechanical, thermal, electric, and other properties. Topics of this course include classifying materials; material structure; thermodynamics and phase transformations; material properties and testing; how solids bend, flow, and ultimately break; and how to choose the right material for design applications. Materials Science is a highly interdisciplinary field and as a result the course prerequisites are broad but also flexible. Interested students who are unsure about their preparation are strongly encouraged to contact the instructor.

Class Format: lecture (3 hours per week) plus three to four small-group laboratory sessions throughout the semester (to be scheduled with instructor)

Requirements/Evaluation: weekly problem sets, class participation, and midterm and final exams, all of which have a substantial quantitative component

Prerequisites: high school physics and chemistry, preferably at the AP level, and MATH 140 or AP Calculus (BC), and one 200-level PHYS, CHEM, or GEOS course; or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: based on students' scientific background and seniority

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Unit Notes: This course does not count toward the Geosciences major.

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHYS 234(D3) GEOS 234(D3)

Quantitative/Formal Reasoning Notes: Weekly problem sets and exams all have a substantial quantitative component.
**Attributes:** MTSC Courses

### Spring 2025

**LEC Section:** 01  
**MR 2:35 pm - 3:50 pm**  
**Katharine E. Jensen**

**PHYS 301 (F) Quantum Physics (QFR)**

This course serves as a one-semester introduction to the formalism, and phenomenology of quantum mechanics, beginning with a discussion of the Schrodinger wave equation, the concept of matter waves, and wave-packets. With this introduction as background, we will continue our discussion with a variety of one-dimensional problems such as the particle-in-a-box and the harmonic oscillator. We then extend this work to systems in two and three dimensions, including a detailed discussion of the structure of the hydrogen atom. Along the way we will develop connections between mathematical formalism and physical predictions of the theory. Finally, we conclude the course with a discussion of angular momentum and spins, with applications to atomic physics, entanglement, and quantum information.

**Class Format:** lecture, three hours per week; laboratory, three hours per week

**Requirements/Evaluation:** weekly problem sets, laboratory reports / write-ups, a midterm exam, and final exam, all of which have a substantial quantitative component

**Prerequisites:** PHYS 202 and PHYS/MATH 210 or MATH 309

**Enrollment Limit:** 8 per lab

**Enrollment Preferences:** physics majors

**Expected Class Size:** 24

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** Phys 301 relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

### Fall 2024

**LEC Section:** 01  
**MWF 9:00 am - 9:50 am**  
**Charlie Doret**

**LAB Section:** 02  
**M 1:00 pm - 4:00 pm**  
**Charlie Doret, Frederick W. Strauch**

**LAB Section:** 03  
**W 1:00 pm - 4:00 pm**  
**Charlie Doret, Frederick W. Strauch**

**LAB Section:** 04  
**R 1:00 pm - 4:00 pm**  
**Charlie Doret, Frederick W. Strauch**

**PHYS 302 (S) Statistical Mechanics & Thermodynamics (QFR)**

Macroscopic objects are made up of huge numbers of fundamental particles interacting in simple ways--obeying the Schrödinger equation, Newton’s and Coulomb’s Laws--and these objects can be described by macroscopic properties like temperature, pressure, magnetization, heat capacity, conductivity, etc. In this course we will develop the tools of statistical physics, which will allow us to predict the cooperative phenomena that emerge in large ensembles of interacting particles. We will apply those tools to a wide variety of physical questions, including the behavior of gases, polymers, heat engines, biological and astrophysical systems, magnets, and electrons in solids.

**Class Format:** lecture/discussion three hours per week and weekly laboratory work

**Requirements/Evaluation:** weekly problem sets and labs, plus exams, all of which have a substantial quantitative component

**Prerequisites:** required: PHYS 201, PHYS/MATH 210 or MATH 309; recommended: PHYS 202, PHYS 301

**Enrollment Limit:** 14 per lab

**Enrollment Preferences:** physics majors

**Expected Class Size:** 25

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** weekly problem sets, exams, and labs, all of which have a substantial quantitative component
PHYS 315  (F)  Computational Biology  (QFR)

Cross-listings:  CSCI 315

Primary Cross-listing

This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and statistics.

Requirements/Evaluation:  weekly Python programming assignments, code reviews, problem sets, plus a few quizzes and a final project

Prerequisites:  programming experience (e.g., CSCI 136) and mathematics (PHYS/MATH 210 or MATH 150) and physical science (PHYS 142/151, or CHEM 101/15X), or permission of instructor

Enrollment Limit:  10

Enrollment Preferences:  if over-enrolled, a questionnaire will be circulated

Expected Class Size:  8

Grading:  no pass/fail option,  no fifth course option

Distributions:  (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

CSCI 315(D3) PHYS 315(D3)

Quantitative/Formal Reasoning Notes:  problem sets and programming assignments

Attributes:  BIGP Courses

Fall 2024

PHYS 321  (S)  Introduction to Particle Physics  (QFR)

The Standard Model of particle physics incorporates special relativity, quantum mechanics, and almost all that we know about elementary particles and their interactions. This course introduces some of the main ideas and phenomena associated with the Standard Model. After a review of relativistic kinematics, we will learn about symmetries in particle physics, relativistic wave equations, elements of quantum field theory, Feynman diagrams, and selected applications of quantum electrodynamics, the weak interactions, and quantum chromodynamics. We will conclude with a discussion of spontaneous symmetry breaking and the Higgs mechanism.

Requirements/Evaluation:  weekly problem sets, a midterm exam, and a final exam

Prerequisites:  PHYS 301

Enrollment Limit:  20

Enrollment Preferences:  By seniority

Expected Class Size:  10

Grading:  yes pass/fail option,  yes fifth course option

Distributions:  (D3)  (QFR)

Quantitative/Formal Reasoning Notes:  Exams and problem sets all have a significant quantitative component.

Spring 2025

LEC Section: 01    TR 11:20 am - 12:35 pm    David R. Tucker-Smith
PHYS 402  (S)  Applications of Quantum Mechanics  (QFR)
This course will explore a number of important topics in the application of quantum mechanics to physical systems, including perturbation theory, the variational principle and the semiclassical interaction of atoms and radiation. The course will finish up with three weeks on quantum optics including an experimental project on non-classical interference phenomena. Applications and examples will be taken mostly from atomic physics with some discussion of solid state systems.

Requirements/Evaluation:  weekly problem sets, tutorial participation, presentations, and a final exam, all of which have a substantial quantitative component
Prerequisites:  PHYS 301
Enrollment Limit:  10 per sec
Enrollment Preferences:  Physics and Astrophysics Majors
Expected Class Size:  16
Grading:  no pass/fail option,  no fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  This course has weekly problem sets, all of which have a substantial quantitative component.

Spring 2025
TUT Section: T1    F 1:10 pm - 2:25 pm    Betul  Pamuk

PHYS 411  (F)  Classical Mechanics  (QFR)
This course will explore advanced topics in classical mechanics. Central ideas include the calculus of variations, the Lagrangian and Hamiltonian formulations of mechanics, phase space, central-force motion, non-inertial reference frames (including implications for physics on a rotating Earth), rigid-body rotations, and non-linear dynamics & chaos, with additional topics from continuum and fluid mechanics as time permits. Numerical and perturbative techniques will be developed and used extensively. We will also examine the ways in which classical mechanics informs other fields of physics. In addition to weekly tutorial meetings the class will meet weekly as a whole to introduce and discuss new material.

Requirements/Evaluation:  weekly problem sets, tutorial participation, presentations, a final project, and a final exam, all of which have a substantial quantitative component
Prerequisites:  PHYS 202 and PHYS/MATH 210 or MATH 309
Enrollment Limit:  30
Enrollment Preferences:  majors
Expected Class Size:  24
Grading:  no pass/fail option,  no fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  weekly problem sets requiring substantial quantitative reasoning using analytical and numerical methods.

Fall 2024
TUT Section: T1    F 1:10 pm - 2:25 pm    Katharine E. Jensen,  Frederick W. Strauch

PHYS 451  (F)  Condensed Matter Physics  (QFR)
Condensed matter physics is an important area of current research and serves as the basis for modern electronic technology. We plan to explore the physics of metals, insulators, semiconductors, superconductors, and photonic crystals, with particular attention to structure, thermal properties, energy bands, and electronic properties.

Requirements/Evaluation:  weekly readings and problem sets, and exams
Prerequisites:  PHYS 301 (may be taken simultaneously); or permission of instructor
Enrollment Limit:  10
Enrollment Preferences:  Physics majors
Expected Class Size:  6
POEC 253 (F) Empirical Methods in Political Economy  (WS) (QFR)
This course introduces students to common empirical tools used in policy analysis and implementation. Students will develop skills in statistical literacy to become critical consumers of public policy-relevant research. The emphasis in the course is split between an intuitive understanding of statistical foundations, and applications in data visualization and science communication. Through hands-on work with data and critical assessment of existing empirical social scientific research, students will develop the ability to choose and employ the appropriate tool for a particular research problem, and to understand the limitations of the techniques. Topics to be covered include basic principles of probability; effective data visualization; statistical inference and hypothesis testing; and multiple regression analysis. A particular focus will be placed on understanding causality, the challenges of estimating causal relationships, and the design of evidence-based policy. Throughout the course, the focus will be on public policy applications relevant to the fields of political science, sociology, and public health, as well as to economics.

Requirements/Evaluation: Problem sets, group project, midterm exam, final exam
Prerequisites: MATH 130 or its equivalent; one course in ECON; not open to students who have taken ECON 255
Enrollment Limit: 20
Enrollment Preferences: Political Economy majors, Environmental Policy majors and sophomores
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: does not satisfy the econometrics requirement for the Economics major; POEC 253 cannot be substituted for ECON 255, or count as an elective towards the Economics major
Distributions: (D2) (WS) (QFR)
Writing Skills Notes: Students will write 3 coding-intensive data briefs over the course of the semester. Creation of original exhibits from publicly accessible data, use of citation management systems, and clarity in technical writing will be emphasized.
Quantitative/Formal Reasoning Notes: The course teaches econometrics, i.e. statistics as economists use it, with applications in economics, political science, and other fields.
Attributes: POEC Required Courses

PSYC 201 (F)(S) Experimentation and Statistics  (QFR)
An introduction to the basic principles of research in psychology. We focus on how to design and execute experiments, analyze and interpret results, and write research reports. Students conduct a series of research studies in different areas of psychology that illustrate basic designs and methods of analysis. You must register for lab and lecture with the same instructor.

Requirements/Evaluation: research reports, exams, and problem sets
Prerequisites: PSYC 101; not open to first-year students except with permission of instructor
Enrollment Limit: 16
Enrollment Preferences: Psychology majors
Expected Class Size: 16
Grading: no pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18

Enrollment Preferences: Students without prior college-level courses in statistics and programming.

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.
STAT 101 (F)(S) Elementary Statistics and Data Analysis (QFR)
It is impossible to be an informed citizen in today’s world without an understanding of data. Whether it is opinion polls, unemployment rates, salary differences between men and women, the efficacy of vaccines, etc, we need to be able to interpret and gain information from statistics. This course will introduce the common methods used to analyze and present data with an emphasis on interpretation and informed decision making.

Requirements/Evaluation: weekly homework, quizzes, exams, and a project
Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test)
Enrollment Limit: 50
Enrollment Preferences: juniors and seniors
Expected Class Size: 35
Grading: yes pass/fail option, yes fifth course option
Unit Notes: Students with MATH150 but no statistics should enroll in STAT201. Students with AP Stat 4/5 or STAT 101/161 should enroll in STAT 202.
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: It is a quantitative course.
Attributes: COGS Related Courses PHLH Statistics Courses

Fall 2024
LEC Section: 01 MWF 11:00 am - 11:50 am Mihai Stoiciu

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Anna M. Plantinga

STAT 161 (F)(S) Introductory Statistics for Social Science (QFR)
This course will cover the basics of modern statistical analysis with a view toward applications in the social sciences. Topics include exploratory data analysis, linear regression, basic statistical inference, and elements of probability theory. The course focuses on the application of statistical tools to solve problems, to make decisions, and the use of statistical thinking to understand the world.

Requirements/Evaluation: Weekly homework, quizzes, two midterms and a final exam (midterms include take-home components), and a data analysis project. Students will need to become familiar with the statistical software STATA.
Prerequisites: MATH 130 (or equivalent); not open to students who have completed STAT 101 or equivalent
Enrollment Limit: 40
Enrollment Preferences: Economics majors, sophomores
Expected Class Size: 40
Grading: yes pass/fail option, no fifth course option
Unit Notes: Students with calculus background should consider STAT 201. Students without any calculus background should consider STAT 101. Students with AP Stat 4 or 5 should consider Stat 202. Please refer to the placement chart on the Math&Stat department website for more information.
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: Reasoning with data
Attributes: PHLH Statistics Courses

Fall 2024
LEC Section: 01 MWF 9:00 am - 9:50 am Duncan A. Clark
LEC Section: 02 MWF 11:00 am - 11:50 am Duncan A. Clark
STAT 201  (F)(S)  Statistics and Data Analysis  (QFR)

Statistics can be viewed as the art and science of turning data into information. Real world decision-making, whether in business or science, is often based on data and the perceived information it contains. Sherlock Holmes, when prematurely asked the merits of a case by Dr. Watson, snapped back, "Data, data, data! I can't make bricks without clay." In this course, we will study the basic methods by which statisticians attempt to extract information from data. These will include many of the standard tools of statistical inference such as hypothesis testing, confidence intervals, and linear regression as well as exploratory and graphical data analysis techniques. This is an accelerated introductory statistics course that involves computational programming and incorporates modern statistical techniques.

Requirements/Evaluation: weekly homework and projects, midterm exams, and a final exam.
Prerequisites: MATH 150 or equivalent; not open to students who have completed STAT 101 or STAT 161 or equivalent
Enrollment Limit: 40
Enrollment Preferences: Prospective Statistics majors, students for whom the course is a major prerequisite, and seniors
Expected Class Size: 40
Grading: yes pass/fail option, yes fifth course option
Unit Notes: Students with AP Stat 4/5 or STAT 101/161 should enroll in STAT 202. Students with no calc or stats background should enroll in STAT 101. Students with MATH 140 but no statistics should enroll in STAT 161.
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: Students will learn to choose, carry out, interpret, and communicate analyses of data.
Attributes: COGS Related Courses  PHLH Statistics Courses

Fall 2024
LEC Section: 01  TF 1:10 pm - 2:25 pm  Elizabeth M. Upton

Spring 2025
LEC Section: 01  TF 1:10 pm - 2:25 pm  Elizabeth M. Upton

STAT 202  (F)(S)  Introduction to Statistical Modeling  (QFR)

Data come from a variety of sources: sometimes from planned experiments or designed surveys, sometimes by less organized means. In this course we’ll explore the kinds of models and predictions that we can make from both kinds of data, as well as design aspects of collecting data. We’ll focus on model building, especially multiple regression, and talk about its potential to answer questions about the world -- and about its limitations. We’ll emphasize applications over theory and analyze real data sets throughout the course.

Requirements/Evaluation: Homework problems; quizzes; exams; a final project (on a topic that interests you!). Participation matters! Engagement with your peers is an important part of learning, of being a statistician in the Real World...and of your evaluation in this course. While your assignments will be submitted (and graded) individually, you’ll be responsible for giving and receiving peer feedback, contributing to class discussions, and working together with classmates on practice problems.

Prerequisites: MATH 140 and STAT 101/161/201/AP Statistics 4/5, or permission of instructor.
Enrollment Limit: 40
Enrollment Preferences: Prospective Statistics majors and more senior students
Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Unit Notes: Students with a 4 on the AP Stats exam should contact the department for proper placement. Students with STAT 201 are strongly encouraged to take STAT 346 or other 300-level statistics electives.
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This course uses mathematical tools and computing programs to create models, make predictions, assess
uncertainty, and describe data. We'll also emphasize choosing appropriate mathematical tools and interpreting their results in a real-world context.

**Attributes:** PHLH Statistics Courses

### Fall 2024

**LEC Section:** 01  TR 8:30 am - 9:45 am  Anna C. Neufeld

**LEC Section:** 02  TR 9:55 am - 11:10 am  Anna C. Neufeld

### Spring 2025

**LEC Section:** 01  TR 8:30 am - 9:45 am  Anna C. Neufeld

**LEC Section:** 02  TF 1:10 pm - 2:25 pm  Xizhen Cai

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**STAT 335 (S) Introduction to Biostatistics and Epidemiology** *(QFR)*

Epidemiology is the study of disease and disability in human populations, while biostatistics focuses on the development and application of statistical methods to address questions that arise in medicine, public health, or biology. This course will begin with epidemiological study designs and core concepts in epidemiology, followed by key statistical methods in public health research. Topics will include multiple regression, analysis of categorical data (two sample methods, sets of 2x2 tables, RxC tables, and logistic regression), survival analysis (Cox proportional hazards model), and if time permits, a brief introduction to regression with correlated data.

**Requirements/Evaluation:** Evaluation will be primarily based on weekly assignments (regular homework or mini-projects), two midterm exams, and a final exam.

**Prerequisites:** Stat 201 or Stat 202, or permission of instructor (prior experience should include a working understanding of multiple linear regression, the basics of statistical inference, and R).

**Enrollment Limit:** 20

**Enrollment Preferences:** Statistics majors and prospective majors who have not yet taken Stat 346; public health concentrators

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** Students will learn how to choose, implement, and interpret statistical analyses relevant to public health studies.

**Attributes:** PHLH Statistics Courses

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**STAT 341 (F)(S) Probability** *(QFR)*

**Cross-listings:** MATH 341

**Secondary Cross-listing**

The historical roots of probability lie in the study of games of chance. Modern probability, however, is a mathematical discipline that has wide applications in a myriad of other mathematical and physical sciences. Drawing on classical gaming examples for motivation, this course will present axiomatic and mathematical aspects of probability. Included will be discussions of random variables (both discrete and continuous), distribution and expectation, independence, laws of large numbers, and the well-known Central Limit Theorem. Many interesting and important applications will also be presented, including some from classical Poisson processes, random walks and Markov Chains.

**Requirements/Evaluation:** homework, classwork, and exams

**Prerequisites:** MATH 150 and MATH 250 or permission of the instructor

**Enrollment Limit:** 50

**Enrollment Preferences:** Priority will be given to Mathematics majors and to Statistics Majors.

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option
Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
STAT 341(D3)  MATH 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2024
LEC Section: 01  MWF 12:00 pm - 12:50 pm  Mihai Stoiciu

Spring 2025
LEC Section: 01  TR 9:55 am - 11:10 am  Steven J. Miller

STAT 342  (S)  Introduction to Stochastic Processes  (QFR)
Stochastic processes are mathematical models for random phenomena evolving in time or space. Examples include the number of people in a queue at time t or the accumulated claims paid by an insurance company in an interval of time t. This course introduces the basic concepts and techniques of stochastic processes used to construct models for a variety of problems of practical interest. The theory of Markov chains will guide our discussion as we cover topics such as martingales, random walks, Poisson process, birth and death processes, and Brownian motion.

Requirements/Evaluation:  weekly homework/labs, classwork, and exams
Prerequisites:  STAT 341
Enrollment Limit:  30
Enrollment Preferences:  senior Statistics majors
Expected Class Size:  15
Grading:  yes pass/fail option,  yes fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This is a statistics class with a focus on mathematical skills and translating real world phenomena into mathematical descriptions.

Spring 2025
LEC Section: 01  TF 2:35 pm - 3:50 pm  Elizabeth M. Upton

STAT 344  (S)  Statistical Design of Experiments  (QFR)
When you hear the word experiment you might be picturing white lab coats and pipettes, but businesses, especially e-commerce, are constantly experimenting as well. How do you get the most out of both scientific and business investigations? By doing the right experiment in the first place.
We'll explore the techniques used to plan experiments that are both efficient and statistically sound. We'll learn how to analyze the data that come from these experiments and the conclusions we can draw from that analysis. We'll look at both classical tools like fractional factorial designs as well as optimal design, and see how these two frameworks differ in their philosophy and in what they can do. Throughout the course, we'll make extensive use of both R and JMP software to work with real-world data.

Requirements/Evaluation:  Homework problems--both individual and in groups, midterm, final, and projects (on topics that interest you!).
Prerequisites:  STAT 161 or 201 or 202, or equivalent, and Math 140 or equivalent, or permission of instructor
Enrollment Limit:  20
Enrollment Preferences:  Statistics majors, seniors, juniors, sophomores, first years
Expected Class Size:  15
Grading:  yes pass/fail option,  yes fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This course uses mathematical tools and computing programs to design experiments, analyze their results, and assess their effectiveness. We'll also emphasize choosing appropriate mathematical tools and interpreting their results in a real-world context.

Spring 2025
STAT 346  (F)(S)  Regression Theory and Applications  (QFR)
This course focuses on the building of empirical models through data in order to predict, explain, and interpret scientific phenomena. Regression modeling is the most widely used method for analyzing and predicting a response data and for understand the relationship with explanatory variables. This course provides both theoretical and practical training in statistical modeling with particular emphasis on simple linear and multiple regression, using R to develop and diagnose models. The course covers the theory of multiple regression and diagnostics from a linear algebra perspective with emphasis on the practical application of the methods to real data sets. The data sets will be taken from a wide variety of disciplines.

Requirements/Evaluation:  Weekly homework, quizzes, theory and data analysis exams, and final course project.
Prerequisites:  MATH/STAT 341, MATH 250, and at least one of STAT 201 or 202. Or permission of the instructor.
Enrollment Limit:  30
Enrollment Preferences:  Statistics Majors
Expected Class Size:  20
Grading:  yes pass/fail option,  no fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  This course prepares students in the use of quantitative methods for the modeling, prediction and understanding of scientific phenomena.

Fall 2024
LEC Section: 01   TR 9:55 am - 11:10 am   Xizhen Cai

Spring 2025
LEC Section: 01   TR 9:55 am - 11:10 am   Xizhen Cai

STAT 355  (F)  Multivariate Statistical Analysis  (QFR)
To better understand complex processes, we study how variables are related to one another and how they work in combination. In addition, we want to make inferences about more than one variable at a time. Elementary statistical methods might not apply. In this course, we study the tools and the intuition that are necessary to analyze and describe such datasets with more than multiple variables. Topics covered will include data visualization techniques for data sets with more variables, clustering algorithms, parametric and non-parametric techniques to estimate joint distributions, techniques for combining variables, performing dimension reduction, and making inferences.

Requirements/Evaluation:  Homework, projects, quizzes, and exams.
Prerequisites:  MATH 250, and STAT 346 or permission of instructor
Enrollment Limit:  15
Enrollment Preferences:  Juniors/seniors
Expected Class Size:  10
Grading:  yes pass/fail option,  no fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  It is an advanced statistics class with prerequisites that are QFR courses

Fall 2024
LEC Section: 01   TF 1:10 pm - 2:25 pm   Xizhen Cai

STAT 360  (F)  Statistical Inference  (QFR)
How do we estimate unknown parameters and express the uncertainty we have in our estimate? Is there an estimator that works best? Many topics from introductory statistics such as random variables, the central limit theorem, point and interval estimation and hypotheses testing will be revisited and put on a more rigorous mathematical footing. The focus is on maximum likelihood estimators and their properties. Bayesian and computer
intensive resampling techniques (e.g., the bootstrap) will also be considered.

Requirements/Evaluation: Homework, Quizzes, Exams
Prerequisites: MATH 250, STAT 201 or 202, STAT 341
Enrollment Limit: 15
Enrollment Preferences: Statistics majors
Expected Class Size: 15
Grading: no pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: A rigorous mathematical course laying the foundation for reasoning with data

Fall 2024
LEC Section: 01  MWF 10:00 am - 10:50 am  Richard D. De Veaux

STAT 442 (S) Statistical Learning and Data Mining (QFR)
In both science and industry today, the ability to collect and store data can outpace our ability to analyze it. Traditional techniques in statistics are often unable to cope with the size and complexity of today's data bases and data warehouses. New methodologies in Statistics have recently been developed, designed to address these inadequacies, emphasizing visualization, exploration and empirical model building at the expense of traditional hypothesis testing. In this course we will examine these new techniques and apply them to a variety of real data sets.
Class Format: Students cannot take both STAT 315 and STAT 442. Only one of the two can be taken for credit.
Requirements/Evaluation: class participation, weekly homework, exams and an end-of-term project
Prerequisites: MATH/STAT 341 and STAT 346, or permission of instructor
Enrollment Limit: 20
Enrollment Preferences: Statistics majors, juniors and seniors. Students cannot take both STAT 315 and STAT 442. Only one of the two can be taken for credit.
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is an advanced statistics class involving theory and application of statistical methods to data.

Spring 2025
LEC Section: 01  MR 2:35 pm - 3:50 pm  Anna C. Neufeld

STAT 458 (F) Generalized Linear Models- Theory and Applications (QFR)
This course will explore generalized linear models (GLMs)--the extension of linear models, discussed in Stat346, to response variables that have specific non-normal distributions, such as counts and proportions. We will consider the general structure and theory of GLMs and see their use in a range of applications. As time permits, we will also examine extensions of these models for clustered data such as mixed effects models and generalized estimating equations.
Requirements/Evaluation: Weekly homework consisting of theoretical exercises and data analyses carried out in R. Short frequent quizzes and one midterm (with an in-class and take-home component). Final project and final exam.
Prerequisites: STAT 346, or permission of instructor
Enrollment Limit: 20
Enrollment Preferences: Seniors and Statistics majors
Expected Class Size: 10
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is an intensive statistics course, involving theoretical and mathematical reasoning as well as the application of mathematical ideas to data using software.

Fall 2024
LEC Section: 01    TF 2:35 pm - 3:50 pm    Elizabeth M. Upton

STS 150 (F) Data for Justice (DPE) (QFR)
Cross-listings: AMST 150 / SOC 150 / WGSS 150 / INTR 150

Secondary Cross-listing
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

Class Format: This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18
Enrollment Preferences: Students without prior college-level courses in statistics and programming.
Expected Class Size: 18
Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 01    TR 9:55 am - 11:10 am    Chad M. Topaz
LEC Section: 02    TR 11:20 am - 12:35 pm    Chad M. Topaz

STS 363 (S) Data for Justice Research Practicum (DPE) (QFR)
Cross-listings: WGSS 363 / INTR 350 / AMST 363

Secondary Cross-listing
Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this
This course is to build skills for advanced research.

**Class Format:** This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

**Requirements/Evaluation:** To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

**Prerequisites:** INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

**Enrollment Limit:** 10

**Enrollment Preferences:** Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor’s preregistration survey (contact the instructor for link).

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**
WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

**Difference, Power, and Equity Notes:** Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

**Quantitative/Formal Reasoning Notes:** Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

**SEM Section: 01** TR 9:55 am - 11:10 am Chad M. Topaz

**SEM Section: 02** TR 11:20 am - 12:35 pm Chad M. Topaz

**WGSS 150  (F)  Data for Justice  (DPE) (QFR)**

**Cross-listings:** STS 150 / AMST 150 / SOC 150 / INTR 150

**Secondary Cross-listing**
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

**Class Format:** This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

**Requirements/Evaluation:** Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

**Prerequisites:** None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

**Enrollment Limit:** 18

**Enrollment Preferences:** Students without prior college-level courses in statistics and programming.

**Expected Class Size:** 18

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**
Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGTBO+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 01    TR 9:55 am - 11:10 am   Chad M. Topaz
LEC Section: 02    TR 11:20 am - 12:35 pm   Chad M. Topaz

WGSS 363  (S)  Data for Justice Research Practicum  (DPE) (QFR)
Cross-listings: STS 363 / INTR 350 / AMST 363
Secondary Cross-listing

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10

Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor's preregistration survey (contact the instructor for link).

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

Difference, Power, and Equity Notes: Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

Quantitative/Formal Reasoning Notes: Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025
SEM Section: 01    TR 9:55 am - 11:10 am   Chad M. Topaz
SEM Section: 02    TR 11:20 am - 12:35 pm   Chad M. Topaz

AMST 150  (F)  Data for Justice  (DPE) (QFR)
Cross-listings: STS 150 / SOC 150 / WGSS 150 / INTR 150
Secondary Cross-listing
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

Class Format: This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18

Enrollment Preferences: Students without prior college-level courses in statistics and programming.

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGTBO+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz
LEC Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz

AMST 363 (S) Data for Justice Research Practicum (DPE) (QFR)

Cross-listings: WGSS 363 / STS 363 / INTR 350

Secondary Cross-listing

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10

Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the
instructor’s preregistration survey (contact the instructor for link).

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

**Difference, Power, and Equity Notes:** Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

**Quantitative/Formal Reasoning Notes:** Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 01  TR 9:55 am - 11:10 am  Chad M. Topaz

SEM Section: 02  TR 11:20 am - 12:35 pm  Chad M. Topaz

**ASTR 111  (F) Introduction to Astrophysics  (QFR)**

The science of astronomy spans vast scales of space and time, from individual atoms to entire galaxies and from the universe's beginning to the future fate of our Sun. In this course, we will survey some of the main ideas in modern astrophysics, with an emphasis on the physics of stars and galaxies.

ASTR 111 is the first course in the Astrophysics and Astronomy major sequences. It is also appropriate for students planning to major in one of the other sciences or mathematics and for others who would like a quantitative introduction that emphasizes the relationship of contemporary physics to astronomy. Topics include gravity and orbits, radiation laws and stellar spectra, physical characteristics of the Sun and other stars, star formation and evolution, black holes, galaxies, the expanding universe, and the Big Bang. Students will also use telescopes to observe stars, nebulae, planets, and galaxies and to make daytime observations of the Sun.

**Class Format:** The class has weekly afternoon laboratory sessions, which will alternate between 'hands-on' activities and problem-solving/discussion sessions. Nighttime observing sessions will occur throughout the semester.

**Requirements/Evaluation:** weekly problem sets, two hour-long tests, a final exam, lab reports, and an observing portfolio

**Prerequisites:** a year of high school Physics, concurrent college Physics, or permission of instructor, and MATH 140 or equivalent

**Enrollment Limit:** 28; 14/lab

**Enrollment Preferences:** potential Astronomy majors

**Expected Class Size:** 15

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** The course requires regular problem sets and quantitative assignments. The course will emphasize how physical equations explain the observed properties of the universe.

Fall 2024

LEC Section: 01  TR 11:20 am - 12:35 pm  Anne Jaskot

LAB Section: 03  R 1:10 pm - 3:50 pm  Kevin Flaherty, Anne Jaskot

LAB Section: 02  M 1:10 pm - 3:50 pm  Kevin Flaherty, Anne Jaskot

**ASTR 206  (S) Astrobiology  (QFR)**

This course will focus on the development of complex life and its observational signatures, both on Earth and on other worlds. We will first investigate the conditions that have led to the development of complex life on Earth. We will view Earth over time from an outsider's perspective and challenge preconceptions about the basic requirements for life. We will also explore the 'hot spots' in the search for life beyond Earth in our Solar System.

Observations in the next decade may reveal biosignatures in the atmospheres of exoplanets. We will learn about these future observations, while also interacting with current research-grade data for other planets and learning about the methods used to constrain the physical conditions on other worlds. Using quantitative models, we will test the stability of Earth-like planets to the variable and potentially hostile conditions of evolving solar
systems.

Requirements/Evaluation: weekly problem sets, one paper, two mid-term exams, and a final exam

Prerequisites: Math 130 and at least one prior physical science course (either Astronomy, Physics, Geosciences, or Chemistry), or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: Science majors, with preference given to students majoring in Astronomy, Astrophysics, or Geosciences

Expected Class Size: 12

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: In this course students will make quantitative comparisons between environmental conditions on Earth, other planetary bodies, and models. The students will also examine observations regarding the detection and characterization of planetary bodies, including contemporary data.

Spring 2025

LEC Section: 01 MR 2:35 pm - 3:50 pm Jason E. Young

ASTR 402 (S) Between the Stars: The Interstellar Medium (QFR)

The matter between the stars—the interstellar medium—tells the story of the evolution of galaxies and the stars within them. Stars are accompanied by diffuse matter all through their lifetimes, from their birthplaces in dense molecular clouds, to the stellar winds they eject as they evolve, and to their final fates as they shed their outer layers, whether as planetary nebulae or dazzling supernovae. As these processes go on, they enrich the interstellar medium with the products of the stars’ nuclear fusion. Interpreting the emission from this interstellar gas is one of astronomers’ most powerful tools to measure the physical conditions, motions, and composition of our own galaxy and others. In this course we will study the interstellar medium in its various forms, from cold, dense, star-forming molecular clouds to X-ray-emitting bubbles formed by supernovae. We will learn about the physical mechanisms that produce the radiation we observe, including radiative ionization and recombination, collisional excitation of “forbidden” lines, collisional ionization, and synchrotron radiation. Applying our understanding of these processes, we will analyze the physical conditions and chemical compositions of a variety of nebulae. Finally, we will discuss the evolution of interstellar material in galaxies across cosmic time. This course is observing-intensive. Throughout the semester, students will work in small groups to design, carry out, analyze, and critique their own observations of the interstellar medium taken using the rooftop telescope.

Class Format: Tutorial meetings will be scheduled with the professor. Students will also complete observing projects using the rooftop telescope.

Requirements/Evaluation: weekly problem sets, 10-page final paper, and observing projects

Prerequisites: ASTR 111 and PHYS 201 or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: juniors and seniors

Expected Class Size: 6

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: In this course, students will derive quantitative physical formulas, use these equations to calculate and compare physical properties, and generate and analyze graphical representations of data. They will also make and analyze measurements of astronomical data through observing projects.

Spring 2025

TUT Section: T1 TBA Anne Jaskot

ASTR 413 (F) Building Stars: A Physical Model of Stellar Structure (QFR)

How does the Sun shine? How does the Sun evolve with time? What physical processes determine the power output of the Sun? In this course we will explore our modern understanding of how stars work, and why they have a range of sizes, temperatures, and luminosities. As we go, we will discuss the laws of physics at work in our Sun and other stars. Over the course of the semester, we will build a working computer model of the Sun using the
basic laws of nuclear fusion, radiative transfer, thermal mechanics, and hydrostatic equilibrium.

Class Format: Lectures will include time for computer programming work

Requirements/Evaluation: weekly problem sets, weekly coding homework assignments, two mid-term exams, and a final project

Prerequisites: PHYS 142 or 151, any prior class that makes use of programming, or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Astronomy, Astrophysics, or Physics majors, with first preference to Astronomy or Astrophysics majors

Expected Class Size: 6

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: In this course, students will use differential equations and numerical coding techniques to test and explore the relationships between physical laws using the Sun and other stars as examples. They will make quantitative comparisons between their calculations and observed stellar properties.

Fall 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Jason E. Young

ASTR 498 (S) Independent Study: Astronomy or Astrophysics (QFR)

Astronomy/Astrophysics independent study, directed by one of the Astronomy faculty: Pasachoff/Jaskot/Flaherty

Requirements/Evaluation: Regular work with the instructor; submitted presentations and papers as agreed upon

Prerequisites: suitable Astronomy/Astrophysics/Physics/Math-Stats-Geosciences/Chemistry courses

Enrollment Limit: 10

Enrollment Preferences: research topic

Expected Class Size: 5

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Substantial quantitative and formal reasoning are involved

Spring 2025

IND Section: 01 TBA David R. Tucker-Smith

BIMO 321 (F) Biochemistry I: Structure and Function of Biological Molecules (QFR)

Cross-listings: BIOL 321 / CHEM 321

Primary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

Enrollment Limit: 12/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators
This is a detailed description of the course BIMO 322 (S) Biochemistry II: Metabolism, a course that offers in-depth study of the complex metabolic reactions central to life. The course consists of lectures and laboratory sessions, focusing on biochemical mechanisms and metabolic pathways. Students will learn about the regulation and integration of metabolic pathways, coenzymes, and the synthesis and catabolism of small molecules. The laboratory component introduces enzymatic reactions, bioenergetics, and metabolic pathways.

**Requirements/Evaluation:**
- Several exams and performance in laboratories focusing on conceptual and quantitative analyses of data.

**Prerequisites:**
- BIOL 101, plus either:
  - CHEM 156 and CHEM 256,
  - CHEM 155 and CHEM 156,
  - CHEM 200 and CHEM 201,
- Permission of instructor

**Enrollment Limit:**
- 48

**Enrollment Preferences:**
- Junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:**
- 48

**Grading:**
- No pass/fail option, no fifth course option

**Unit Notes:**
- Cannot be counted towards the Biology major in addition to BIOL 222

**Distributions:**
- (D3) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**
- BIMO 322(D3) CHEM 322(D3) BIOL 322(D3)

**Quantitative/Formal Reasoning Notes:**
- The laboratory program is quantitative, covering data analyses, numerical transformations, and graphical displays.

**Attributes:**
- BIGP Courses
- BIMO Required Courses

**Fall 2024**
- LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi
- LAB Section: 02 T 1:00 pm - 5:00 pm
- LAB Section: 03 W 1:00 pm - 5:00 pm
- LAB Section: 04 R 1:00 pm - 5:00 pm

**Spring 2025**
- LAB Section: 02 M 1:00 pm - 3:50 pm Caitlyn E. Bowman-Cornelius
- LEC Section: 01 TR 11:20 am - 12:35 pm Caitlyn E. Bowman-Cornelius
- LAB Section: 03 W 1:00 pm - 3:50 pm Caitlyn E. Bowman-Cornelius
BIOL 202  (F) Genetics  (QFR)
Genetics, classically defined as the study of heredity, is today a multidisciplinary field whose principles provide critical insight and tools to most areas of biology and medicine. This course covers the experimental basis for our current understanding of the inheritance, structures, and functions of genes. It introduces approaches used by contemporary geneticists and molecular biologists to explore questions in areas of biology ranging from evolution to medicine. A primary focus of the course is on students developing familiarity with problem solving, the logic and quantitative reasoning required to understand how genetic mechanisms lead to biological patterns. The laboratory part of the course provides an experimental introduction to modern genetic analysis as well as introductions to interpreting genetic reasoning in the primary research literature. Laboratory experiments include investigating chromosome structure using microscopy, mapping a mutation to the genome by integrating multiple streams of evidence, and determining the structure of a DNA plasmid using molecular tools.

Class Format: Lecture: three hours per week, Lab: three hours per week.

Requirements/Evaluation: bi-weekly problem sets; weekly laboratory exercises and laboratory reports; three exams

Prerequisites: BIOL 101 and 102

Enrollment Limit: 120

Enrollment Preferences: students interested in the Biology major

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: This course develops quantitative skills through solving problems. Students learn to apply basic calculations and logic to predict the outcomes of biological systems, for example, describing the likelihood that an individual will be affected by an inherited disease. Application of quantitative and logical analysis contributes to a large component of the in-class work and the graded material for the class, in the form of problem sets, exams, and data analysis for lab reports.

Attributes: BIGP Courses  BIMO Required Courses

BIOL 203  (F) Ecology  (QFR)

Cross-listings: ENVI 203

Primary Cross-listing
This course combines lectures & discussion with field and indoor laboratory activities to explore factors that determine the distribution and abundance of plants and animals in natural systems. The course begins with an overview of global environmental patterns and then builds from the population to ecosystem level. Throughout the course, we will emphasize the connection between basic ecological principles and current environmental issues. Selected topics include population dynamics (competition, predation, mutualism); community interactions (succession, food chains and diversity) and ecosystem function (biogeochemical cycles, energy flow). Laboratory activities are designed to engage students in the natural history of the region and build skills in data analysis and scientific writing.

Requirements/Evaluation: pre-class quizzes, lab reports, two mid-term exams, and a final exam

Prerequisites: BIOL 102, or ENVI 102, or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: students planning to pursue Biology and/or ENVI

Expected Class Size: 30
Grading:  yes pass/fail option,   yes fifth course option

Distributions:  (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIOL 203(D3)  ENVI 203(D3)

Quantitative/Formal Reasoning Notes: Much of the material in this course centers on the interpretation and application of mathematical models used to describe ecological systems. The laboratory section of this course also contains a large data analysis component (based in R). Students are introduced to linear models, multidimensional data analysis and contingency tables.

Attributes:  ENVI Natural World Electives  EVST Environmental Science

Fall 2024
LEC Section: 01    TR 8:30 am - 9:45 am     Manuel A. Morales
LAB Section: 02    T 1:00 pm - 3:50 pm     Manuel A. Morales
LAB Section: 03    W 1:00 pm - 3:50 pm     Manuel A. Morales

BIOL 305  (S)  Evolution  (QFR)
This course offers a critical analysis of contemporary concepts in biological evolution. We focus on the relation of evolutionary mechanisms (e.g., selection, drift, and migration) to long term evolutionary patterns (e.g., evolutionary innovations, origin of major groups, and adaptation). Topics include micro-evolutionary models, natural and sexual selection, speciation, the inference of evolutionary history, evolutionary medicine among others.

Requirements/Evaluation:  independent research project, problem sets, participation in discussions and exams
Prerequisites:  BIOL 102 and one 200 level BIOL course
Enrollment Limit:  24
Enrollment Preferences:  Seniors and biology majors
Expected Class Size:  24
Grading:  yes pass/fail option,   yes fifth course option
Unit Notes:  satisfies the distribution requirement for the Biology major
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  We will use mathematical models to study population genetics.
Attributes:  BIGP Courses  BIMO Interdepartmental Electives  COGS Related Courses

Spring 2025
LEC Section: 01    TR 11:20 am - 12:35 pm
LAB Section: 02    M 1:00 pm - 3:50 pm
LAB Section: 03    T 1:00 pm - 3:50 pm

BIOL 321  (F)  Biochemistry I: Structure and Function of Biological Molecules  (QFR)
Cross-listings:  BIMO 321 / CHEM 321
Secondary Cross-listing
This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.
Class Format:  lecture, three times per week and laboratory, four hours per week
Requirements/Evaluation:  quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports
**Prerequisites:** BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

**Enrollment Limit:** 12/lab

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:** 36

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** Cannot be counted towards the Biology major in addition to BIOL 222

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 321(D3) BIMO 321(D3) CHEM 321(D3)

**Quantitative/Formal Reasoning Notes:** This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

**Attributes:** BIGP Courses BIMO Required Courses

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**Fall 2024**

LEC Section: 01 MWF 10:00 am - 10:50 am  B Thuronyi

LAB Section: 03 W 1:00 pm - 5:00 pm

LAB Section: 04 R 1:00 pm - 5:00 pm

LAB Section: 02 T 1:00 pm - 5:00 pm

**BIOL 322 (S) Biochemistry II: Metabolism (QFR)**

**Cross-listings:** BIMO 322 / CHEM 322

**Secondary Cross-listing**

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

**Class Format:** Lecture three hours per week and laboratory three hours per week.

**Requirements/Evaluation:** several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

**Prerequisites:** BIOL 101, plus either: CHEM 156 and CHEM 256, or CHEM 155 and CHEM 156, or CHEM 200 and CHEM 201, or permission of instructor

**Enrollment Limit:** 48

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Expected Class Size:** 48

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** cannot be counted towards the Biology major in addition to BIOL 222

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOM 322(D3) CHEM 322(D3) BIOL 322(D3)

**Quantitative/Formal Reasoning Notes:** The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

**Attributes:** BIGP Courses BIMO Required Courses

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**Spring 2025**
BIOL 420  (S)  Mathematical Biology  (QFR)

Cross-listings: MATH 412

Secondary Cross-listing

This course will provide an introduction to the many ways in which mathematics can be used to understand, analyze, and predict biological dynamics. We will learn how to construct mathematical models that capture essential properties of biological processes while maintaining analytic tractability. Analytic techniques, such as stability and bifurcation analysis, will be introduced in the context of both continuous and discrete time models. Additionally, students will couple these analytic tools with numerical simulation to gain a more global picture of the biological dynamics. Possible biological applications may include, but are not limited to, single and multi-species population dynamics, neural and biological oscillators, tumor cell growth, and infectious disease dynamics.

Requirements/Evaluation: problem sets, quizzes/exams, participation, final project and paper
Prerequisites: MATH 250 and MATH 309, or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: preference for senior math/stats major and also based on an interest statement
Expected Class Size: 30
Grading: yes pass/fail option, no fifth course option
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
MATH 412(D3)  BIOL 420(D3)

Quantitative/Formal Reasoning Notes: The course will introduce methods for developing and analyzing mathematical models.

Spring 2025

CAOS 213  (S)  Introduction to Environmental and Natural Resource Economics  (QFR)

Cross-listings: ECON 213 / ENVI 213

Secondary Cross-listing

We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

Requirements/Evaluation: problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)
Prerequisites: ECON 110 or equivalent
Enrollment Limit: 30
Enrollment Preferences: first-year and sophomore students
Expected Class Size: 30
Grading: yes pass/fail option, yes fifth course option
Unit Notes: this course will count toward both the Environmental Studies major and concentration
Distributions: (D2) (QFR)
CAOS 327 (F) Coastal Processes and Geomorphology  (QFR)
Cross-listings:  ENVI 327 / GEOS 327
Secondary Cross-listing
Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces—wind, waves, storms, and people— that shape the coastal zone, as well as the geologic formations—sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs—that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change. Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week
Requirements/Evaluation: lab reports, quizzes, and an independent research project
Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.
Enrollment Limit: 15
Enrollment Preferences: Geosciences majors
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: This course counts toward the GEOS Group B Electives - Sediments + Life.
Distributions: (D3) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 327(D3) GEOS 327(D3) CAOS 327(D3)
Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.
Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life

Fall 2024
LEC Section: 01  MWF 8:30 am - 9:45 am  Alex A. Apotsos

CAOS 477 (F) Economics of Environmental Behavior  (QFR)
Cross-listings:  ENVI 376 / ECON 477
A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.

**Class Format:** Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities

**Requirements/Evaluation:** class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory

**Prerequisites:** ECON 251 and (ECON 255 or STAT 346)

**Enrollment Limit:** 19

**Enrollment Preferences:** senior Economics majors and junior Economics majors considering a thesis

**Expected Class Size:** 19

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

CAOS 477(D2) ENVI 376(D2) ECON 477(D2)

**Quantitative/Formal Reasoning Notes:** The research students will consume and produce in the class will be based on math-based theory and/or econometric-based empirical analysis.

**Attributes:** CAOS Senior Seminars ENVI Humanities, Arts + Social Science Electives POEC Depth POEC Skills

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**CHEM 100 (F) Chemistry Matters (QFR)**

Chemistry matters! From fueling the world's economy to preventing the next pandemic to forecasting future climate change, chemistry touches all aspects of daily life. This course provides an introduction to chemical principles and applications for students with little or no high school chemistry background. Through the lens of contemporary issues and applications (e.g. energy, environment, materials, medicine, etc.), students will be introduced to concepts fundamental to studying matter at the molecular level. Particular emphasis will be placed on skills essential for students to understand chemistry in these contexts, including quantitative reasoning and the development of chemical literacy and intuition. Laboratory meetings will be used to reinforce lecture material through experimentation at the bench and active learning exercises.

**Class Format:** lecture, three times per week and laboratory, three hours per week

**Requirements/Evaluation:** problem set assignments, laboratory work and analysis, quizzes/exams and a final assessment

**Prerequisites:** Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement).

**Enrollment Limit:** 32; 16/lab

**Enrollment Preferences:** First-year students with little or no high school chemistry experience.

**Expected Class Size:** 32

**Grading:** yes pass/fail option, no fifth course option

**Unit Notes:** CHEM 100 may be taken concurrently with MATH 102—see under Mathematics; CHEM 100 or its equivalent is a prerequisite to CHEM 101.

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course fulfills the QFR requirement with regular problem sets and in class activities in which quantitative/formal reasoning skills are practiced.
CHEM 101 (F)(S) Concepts of Chemistry (QFR)

This course broadens and deepens the foundation in chemistry of students who have had one or more years of chemistry at the high school level. Most students begin study of chemistry at Williams with this course. Familiarity with stoichiometry, basic concepts of equilibria, the model of an atom, Lewis structures and VSEPR, and gas laws is expected. Principal topics for this course include modern atomic theory, molecular structure and bonding, states of matter, chemical equilibrium (acid-base and solubility), and an introduction to atomic and molecular spectroscopies. Laboratory periods will largely focus on experiment design, data analysis, literature, scientific writing, and other skills critical to students' development as scientists. The course is of interest to students who anticipate professional study in chemistry, related sciences, or one of the health professions, as well as to those who want to explore the fundamentals of chemistry as part of their general education. This course may be taken pass/fail; however, students who are considering graduate study in science or in the health professions should elect to take this course for a grade.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: problem sets and/or quizzes, laboratory work, and exams

Prerequisites: Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement) or CHEM 100.

Enrollment Limit: 45; 16/lab

Enrollment Preferences: first-year students

Expected Class Size: 45/lecture

Grading: yes pass/fail option, no fifth course option

Unit Notes: CHEM 101 or its equivalent is a prerequisite for both CHEM 200 and CHEM 201 and is required for the BIMO concentration.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

CHEM 200 (S) Advanced Chemical Concepts (QFR)

This course treats an array of topics in modern chemistry, emphasizing broad concepts that connect and weave through the various subdisciplines of the field--biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. It provides the necessary background in chemical science for students who are planning advanced study or a career in chemistry, biological science, geoscience, environmental science, or a health profession.
Topics include coordination complexes, thermodynamics, electrochemistry, and kinetics. Laboratory sections will give students hands-on experience involving synthesis, characterization, and reactivity studies of coordination and organic complexes; spectroscopic analyses; thermodynamics; electrochemistry; and kinetics. Students will hone their skills in the presentation of results through written reports and worksheets.

**Class Format:** lecture, three times per week and laboratory, four hours per week

**Requirements/Evaluation:** homework assignments, laboratory work, quizzes, midterm exam, and a final exam

**Prerequisites:** CHEM 101

**Enrollment Limit:** 35; 16/lab

**Enrollment Preferences:** first-year students, then sophomores

**Expected Class Size:** 35

**Grading:** no pass/fail option, no fifth course option

**Unit Notes:** CHEM 200 is required for the BIMO concentration

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

**Attributes:** BIMO Required Courses

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**Spring 2025**

LEC Section: 02 MWF 10:00 am - 10:50 am  Enrique Peacock-López

LAB Section: 03 M 1:00 pm - 5:00 pm

LAB Section: 04 T 1:00 pm - 5:00 pm

LEC Section: 01 MWF 9:00 am - 9:50 am  Enrique Peacock-López

LAB Section: 06 R 1:00 pm - 5:00 pm

LAB Section: 05 W 1:00 pm - 5:00 pm

LAB Section: 07 T 8:00 am - 12:00 pm

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**CHEM 201 (F) Organic Chemistry: Introductory Level (QFR)**

This course provides the necessary background in organic chemistry for students who are planning advanced study or a career in chemistry, the biological sciences, or the health professions. It initiates the systematic study of the common classes of organic compounds with emphasis on theories of structure and reactivity. Specific topics include basic organic structures and bonding, delocalization and conjugation, acidity & basicity, nucleophilic addition and substitution reactions, stereochemistry and molecular energetics. The theory and interpretation of infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy, as well as the fundamentals of molecular modeling as applied to organic molecules are presented. The coordinated laboratory work includes organic synthesis, purification and separation techniques, as well as characterization by IR and NMR spectroscopy.

**Class Format:** lecture, three times per week and laboratory, four hours per week

**Requirements/Evaluation:** quantitative problem solving, laboratory performance, three midterm exams, and a final exam

**Prerequisites:** CHEM 101 or CHEM 151, 153, or 155

**Enrollment Limit:** 40; 12/lab

**Enrollment Preferences:** Seniors, juniors, sophomores, first-year students

**Expected Class Size:** 40

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course fulfills the QFR requirement with regular and substantial problem solving in which quantitative/formal reasoning skills are practiced and evaluated.

**Attributes:** BIMO Required Courses

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**Fall 2024**

LAB Section: 09 W 1:00 pm - 5:00 pm
CHEM 321  (F)  Biochemistry I: Structure and Function of Biological Molecules  (QFR)

Cross-listings:  BIOL 321 / BIMO 321

Secondary Cross-listing

This course introduces the foundational concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

Prerequisites: BIOL 101, CHEM 200 and CHEM 201; or either CHEM 155 or 256 and CHEM 251

Enrollment Limit: 12/lab

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 36

Grading: no pass/fail option, no fifth course option

Unit Notes: Cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 321(D3) BIMO 321(D3) CHEM 321(D3)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes: BIGP Courses  BIMO Required Courses

Fall 2024

LAB Section: 04  R 1:00 pm - 5:00 pm

LEC Section: 01  MWF 10:00 am - 10:50 am   B  Thuronyi

LAB Section: 03  W 1:00 pm - 5:00 pm

LAB Section: 02  T 1:00 pm - 5:00 pm

CHEM 322  (S)  Biochemistry II: Metabolism  (QFR)

Cross-listings:  BIMO 322 / BIOL 322

Secondary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that are central to life. Emphasis is placed on the biological
flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

Class Format: Lecture three hours per week and laboratory three hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

Prerequisites: BIOL 101, plus either: CHEM 156 and CHEM 256, or CHEM 155 and CHEM 156, or CHEM 200 and CHEM 201, or permission of instructor

Enrollment Limit: 48

Enrollment Preferences: junior and senior Biology and Chemistry majors and BIMO concentrators

Expected Class Size: 48

Grading: no pass/fail option, no fifth course option

Unit Notes: cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIMO 322(D3) CHEM 322(D3) BIOL 322(D3)

Quantitative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses  BIMO Required Courses

Spring 2025

LAB Section: 03  W 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius
LAB Section: 02  M 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius
LEC Section: 01  TR 11:20 am - 12:35 pm  Caitlyn E. Bowman-Cornelius
LAB Section: 04  R 1:00 pm - 3:50 pm  Caitlyn E. Bowman-Cornelius

CHEM 361 (S) Quantum Chemistry and Chemical Dynamics  (QFR)
This course introduces quantum mechanics, which serves as the basis for understanding molecular structure and spectroscopy. We will begin by discussing the Schrodinger wave equation and then apply this to understanding the translational, vibrational, and rotational structure of molecules. This leads to a discussion of atomic/molecular electronic structure and spectroscopy. Computational methods will be taught to illustrate key quantum mechanical concepts, interpret experimental data, and extend hypotheses. Applications will be chosen from contemporary research fields, including photochemistry, laser spectroscopy, environmental/atmospheric chemistry, organometallic chemistry, and physical organic chemistry.

Requirements/Evaluation: class participation, problem sets, exams, and laboratory work

Prerequisites: CHEM 155 or CHEM 256; or CHEM 200; or permission of instructor; and strongly recommend MATH 150 or MATH 151

Enrollment Limit: 16; 8/lab

Enrollment Preferences: seniors, then juniors

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFC requirement and relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

Spring 2025

LAB Section: 02  T 1:00 pm - 5:00 pm  Ben L. Augenbraun
CHEM 366  (F)  Thermodynamics and Statistical Mechanics  (QFR)

The thermodynamic laws provide us with our most powerful and general scientific principles for predicting the direction of spontaneous change in physical, chemical, and biological systems. This course develops the concepts of energy, entropy, free energy, temperature, heat, work, and chemical potential within the framework of classical and statistical thermodynamics. The principles developed are applied to a variety of problems: chemical reactions, phase changes, energy technology, industrial processes, and environmental science. Laboratory experiments provide quantitative and practical demonstrations of the theory of real and ideal systems studied in class.

Class Format: lecture, three times per week and laboratory, four hours per week

Requirements/Evaluation: class participation, oral presentations, problem sets, laboratory work, and an independent project

Prerequisites: CHEM 155 or CHEM 256; or CHEM 200; and basic knowledge of applied integral and differential calculus

Enrollment Limit: 16/lab

Enrollment Preferences: Chemistry majors: seniors, juniors, then sophomores

Expected Class Size: 16

Grading: no pass/fail option, yes fifth course option

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFC requirement and relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

Attributes: BIMO Interdepartmental Electives

Fall 2024

LAB Section: 02    T 1:00 pm - 5:00 pm    Enrique Peacock-López
LEC Section: 01    MWF 11:00 am - 12:15 pm    Enrique Peacock-López

COGS 224  (F)  Introduction to Formal Linguistics  (QFR)

Cross-listings: PHIL 221

Primary Cross-listing

The sentence “Every cookie is chocolate chip and three of them are oatmeal raisin” is a perfectly grammatical sentence of English, but it’s self-contradictory. What does it take to realize this fact? One must grasp the meanings of the various parts of the sentence. In particular, one must grasp that “three of them” picks out a subset of the group picked out by “every cookie”, and that there’s no such thing as a cookie that is both chocolate chip and oatmeal raisin. There two ways to understand “Many students took every class”. According to one, there is a single group of students that had their hands extremely full this semester. According to the other, every class was well-populated, potentially by different groups. The reason for this is that there are two underlying structures that the original sentence can realize. This course serves as an introduction to formal methods in the scientific study of language. Our goal will be to characterize phenomena like those above with logical and mathematical precision. The focus will be on model-theoretic semantics, the sub-field of linguistics that studies meanings. Along the way we will discuss principles of syntax, the sub-field that studies sentence structures, and pragmatics, the sub-field that studies inferences of non-literal content. This is a formal course, but no prior logical or mathematical background will be expected. Starting from scratch, students will learn the building blocks of current-day linguistic research. This introduction will be of use to students interested in language from a variety of perspectives, including philosophy, cognitive science, and computer science.

Requirements/Evaluation: Weekly problem sets, plus a final project (paper/presentation/other type, to be discussed with instructor)

Prerequisites: No prerequisites

Enrollment Limit: 20

Enrollment Preferences: Preference given to seniors and philosophy/cognitive science majors.

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2)  (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
PHIL 221(D2) COGS 224(D2)

Quantitative/Formal Reasoning Notes: This course teaches the fundamentals of the formal analysis of language. Students will learn to provide translation schemes from English to a logical language (typed lambda calculus).

Attributes: COGS Interdepartmental Electives COGS Related Courses Linguistics PHIL Contemp Metaphysics + Epistemology Courses

Fall 2024
LEC Section: 01 MR 1:10 pm - 2:25 pm Christian De Leon

CSCI 104 (F) Data Science and Computing for All (QFR)

Many of the world's greatest discoveries and most consequential decisions are enabled or informed by the analysis of data from a myriad of sources. Indeed, the ability to wrangle, visualize, and draw conclusions from data is now a critical tool in the sciences, business, medicine, politics, other academic disciplines, and society as a whole. This course lays the foundations for quantifying relationships in data by exploring complementary computational, statistical, and visualization concepts. These concepts will be reinforced by lab experiences designed to teach programming and statistics skills while analyzing real-world data sets. This course will also examine the broader context and social issues surrounding data analysis, including privacy and ethics.

Requirements/Evaluation: Weekly lab assignments involving programming, a project, and examinations.

Prerequisites: None; previous programming experience or statistics is not required.

Enrollment Limit: 30;15/lab

Enrollment Preferences: Not open to those who have completed or are currently enrolled in a Computer Science course numbered 136 or higher. Preference given to those who have not previously taken a computer science or statistics course.

Expected Class Size: 30

Grading: yes pass/fail option, no fifth course option

Unit Notes: Additional details about the class are available here: https://www.cs.williams.edu/~cs104. Please see the Computer Science Department website for more information on selecting an introductory computer science class: https://csci.williams.edu/

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course includes regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024
LAB Section: 03 M 1:00 pm - 2:30 pm Stephen N. Freund
LEC Section: 02 MWF 11:00 am - 11:50 am Stephen N. Freund
LEC Section: 01 MWF 10:00 am - 10:50 am Stephen N. Freund
LAB Section: 06 T 2:30 pm - 4:00 pm Stephen N. Freund
LAB Section: 05 T 1:00 pm - 2:30 pm Stephen N. Freund
LAB Section: 04 M 2:30 pm - 4:00 pm Stephen N. Freund

CSCI 134 (F)(S) Introduction to Computer Science (QFR)

This course introduces students to the science of computation by exploring the representation and manipulation of data and algorithms. We organize and transform information in order to solve problems using algorithms written in a modern object-oriented language. Topics include organization of data using objects and classes, and the description of processes using conditional control, iteration, methods and classes. We also begin the study of abstraction, self-reference, reuse, and performance analysis. While the choice of programming language and application area will vary in different offerings, the skills students develop will transfer equally well to more advanced study in many areas. In particular, this course is designed to provide the programming skills needed for further study in computer science and is expected to satisfy introductory programming requirements in other departments.

Requirements/Evaluation: weekly programming projects, weekly written homeworks, and two examinations.
Prerequisites: none, except for the standard prerequisites for a (QFR) course; previous programming experience is not required

Enrollment Limit: 30/15/lab

Enrollment Preferences: if the course is over-enrolled, enrollment will be determined by lottery.

Expected Class Size: 30/lec

Grading: yes pass/fail option, yes fifth course option

Unit Notes: Please see the Computer Science Department website for more information on selecting an introductory computer science class: https://csci.williams.edu/. Students with prior experience with object-oriented programming should discuss appropriate course placement with members of the department.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course includes regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01  MWF 9:00 am - 9:50 am  Bill K. Jannen
LAB Section: 04  M 1:00 pm - 2:30 pm  Iris Howley
LEC Section: 02  MWF 10:00 am - 10:50 am  Iris Howley
LAB Section: 08  T 2:30 pm - 4:00 pm  Iris Howley
LAB Section: 05  M 1:00 pm - 2:30 pm  Bill K. Jannen
LAB Section: 07  M 2:30 pm - 4:00 pm  Bill K. Jannen
LEC Section: 03  MWF 11:00 am - 11:50 am  Iris Howley
LAB Section: 06  M 2:30 pm - 4:00 pm  Iris Howley
LAB Section: 09  T 2:30 pm - 4:00 pm  Bill K. Jannen

Spring 2025
LAB Section: 04  M 1:00 pm - 2:30 pm  Mark Hopkins
LEC Section: 02  MWF 10:00 am - 10:50 am  Mark Hopkins
LEC Section: 01  MWF 9:00 am - 9:50 am  Laura South
LAB Section: 06  T 1:00 pm - 2:30 pm  Laura South
LAB Section: 05  M 2:30 pm - 4:00 pm  Mark Hopkins
LEC Section: 03  MWF 11:00 am - 11:50 am  Mark Hopkins
LAB Section: 08  T 2:30 pm - 4:00 pm  Laura South
LAB Section: 07  T 1:00 pm - 2:30 pm  Mark Hopkins
LAB Section: 09  T 2:30 pm - 4:00 pm  Mark Hopkins

CSCI 136  (F)(S)  Data Structures and Advanced Programming  (QFR)

This course builds on the programming skills acquired in Computer Science 134. It couples work on program design, analysis, and verification with an introduction to the study of data structures. Data structures capture common ways in which to store and manipulate data, and they are important in the construction of sophisticated computer programs. Students are introduced to some of the most important and frequently used data structures: lists, stacks, queues, trees, hash tables, graphs, and files. Students will be expected to write several programs, ranging from very short programs to more elaborate systems. Emphasis will be placed on the development of clear, modular programs that are easy to read, debug, verify, analyze, and modify.

Requirements/Evaluation: programming and written assignments, quizzes, examinations

Prerequisites: CSCI 134 or equivalent; fulfilling the Discrete Mathematics Proficiency requirement is recommended, but not required

Enrollment Limit: 30/15/lab

Enrollment Preferences: if the course is over-enrolled, enrollment will be determined by lottery.
Expected Class Size: 30/lec

Grading: yes pass/fail option, no fifth course option

Unit Notes: Please see the Computer Science Department website for more information on selecting an introductory computer science class: https://csci.williams.edu/

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course include regular and substantial problem sets, labs, and/or projects in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIGP Courses

Fall 2024
LEC Section: 01  MWF 9:00 am - 9:50 am  James M. Bern
LAB Section: 06  R 2:30 pm - 4:00 pm  James M. Bern
LAB Section: 03  W 1:00 pm - 2:30 pm  James M. Bern
LAB Section: 04  W 2:30 pm - 4:00 pm  James M. Bern
LEC Section: 02  MWF 10:00 am - 10:50 am  James M. Bern
LAB Section: 05  R 1:00 pm - 2:30 pm  James M. Bern

Spring 2025
LAB Section: 03  W 1:00 pm - 2:30 pm  Katie A. Keith
LAB Section: 05  R 1:00 pm - 2:30 pm  Katie A. Keith
LEC Section: 01  MWF 9:00 am - 9:50 am  Katie A. Keith
LEC Section: 02  MWF 10:00 am - 10:50 am  Katie A. Keith
LAB Section: 06  R 2:30 pm - 4:00 pm  Katie A. Keith
LAB Section: 04  W 2:30 pm - 4:00 pm  Katie A. Keith

CSCI 237 (F)(S) Computer Organization (QFR)
This course studies the basic instruction set architecture and organization of a modern computer. It provides a programmer's view of how computer systems execute programs, store information, and communicate. Over the semester the student learns the fundamentals of translating higher level languages into assembly language, and the interpretation of machine languages by hardware. At the same time, a model of computer hardware organization is developed from the gate level upward.

Requirements/Evaluation: weekly programming assignments and/or problem sets, quizzes, midterm and final exams

Prerequisites: CSCI 136

Enrollment Limit: 24;12/lab

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024
LAB Section: 03  W 1:00 pm - 2:30 pm  Kelly A. Shaw
LEC Section: 01  MWF 10:00 am - 10:50 am  Kelly A. Shaw
LAB Section: 05  R 1:00 pm - 2:30 pm  Kelly A. Shaw
LAB Section: 06  R 2:30 pm - 4:00 pm  Kelly A. Shaw
LEC Section: 02  MWF 11:00 am - 11:50 am  Kelly A. Shaw
CSCI 256  (F)(S)  Algorithm Design and Analysis  (QFR)
This course investigates methods for designing efficient and reliable algorithms. By carefully analyzing the structure of a problem within a mathematical framework, it is often possible to dramatically decrease the computational resources needed to find a solution. In addition, analysis provides a method for verifying the correctness of an algorithm and accurately estimating its running time and space requirements. We will study several algorithm design strategies that build on data structures and programming techniques introduced in Computer Science 136. These include greedy, divide-and-conquer, dynamic programming, and network flow algorithms. Additional topics of study include algorithms on graphs and strategies for handling potentially intractable problems.

Requirements/Evaluation: Problem sets, midterm and final examinations
Prerequisites: CSCI 136 and fulfillment of the Discrete Mathematics Proficiency requirement
Enrollment Limit: 24
Enrollment Preferences: Preference will be given to students who need the class in order to complete the major. Ties will be broken by seniority (seniors first, then juniors, etc.).
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course will have weekly problem sets in which students will formally prove statements about the behavior and performance of algorithms. In short, the course is about applying abstract and mathematical reasoning to the study of algorithms and computation.

Fall 2024
LEC Section: 01  MWF 12:00 pm - 12:50 pm  Aaron M. Williams

Spring 2025
LEC Section: 02  MR 2:35 pm - 3:50 pm  Samuel McCauley
LEC Section: 01  MR 1:10 pm - 2:25 pm  Samuel McCauley

CSCI 315  (F)  Computational Biology  (QFR)
Cross-listings: PHYS 315
Secondary Cross-listing
This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and statistics.

Requirements/Evaluation: weekly Python programming assignments, code reviews, problem sets, plus a few quizzes and a final project
Prerequisites: programming experience (e.g., CSCI 136) and mathematics (PHYS/MATH 210 or MATH 150) and physical science (PHYS 142/151, or CHEM 101/15X), or permission of instructor
Enrollment Limit: 10
Enrollment Preferences: if over-enrolled, a questionnaire will be circulated
Expected Class Size: 8
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
CSCI 315(D3) PHYS 315(D3)

Quantitative/Formal Reasoning Notes: problem sets and programming assignments

Attributes: BIGP Courses

Fall 2024
LEC Section: 01 MR 2:35 pm - 3:50 pm Daniel P. Aalberts

CSCI 334 (S) Principles of Programming Languages (QFR)
This course examines the concepts and structures governing the design and implementation of programming languages. It presents an introduction to the concepts behind compilers and run-time representations of programming languages; features of programming languages supporting abstraction and polymorphism; and the procedural, functional, object-oriented, and concurrent programming paradigms. Programs will be required in languages illustrating each of these paradigms.

Requirements/Evaluation: weekly problem sets and programming assignments, a midterm examination, and a final examination
Prerequisites: CSCI 136
Enrollment Limit: 30
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 30
Grading: yes pass/fail option, no fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course include regular and substantial problem sets and labs in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025
LEC Section: 01 MR 1:10 pm - 2:25 pm Daniel W. Barowy
LEC Section: 02 MR 2:35 pm - 3:50 pm Daniel W. Barowy

CSCI 338 (S) Parallel Processing (QFR)
This course explores different parallel programming paradigms used for writing applications on today's parallel computer systems. The course will introduce concurrency (i.e. multiple simultaneous computations) and the synchronization primitives that allow for the creation of correct concurrent applications. It will examine how a variety of systems organize parallel processing resources and enable users to write parallel programs for these systems. Covered programming paradigms will include multiprogramming with processes, message passing, threading in shared memory multiprocessors, vector processing, graphics processor programming, transactions, MapReduce, and other forms of programming for the cloud. Class discussion is based on assigned readings. Assignments provide students the opportunity to develop proficiency in writing software using different parallel programming paradigms.

Requirements/Evaluation: homework assignments, programming projects, and up to two exams
Prerequisites: CSCI 136 or equivalent programming experience, and CSCI 237, or permission of instructor
Enrollment Limit: 24
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of substantial problem sets and programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025
CSCI 339 (F) Distributed Systems (QFR)

This course studies the key design principles of distributed systems, which are collections of independent networked computers that function as single coherent systems. Covered topics include communication protocols, processes and threads, naming, synchronization, consistency and replication, fault tolerance, and security. Students also examine some specific real-world distributed systems case studies, including Google and Amazon. Class discussion is based on readings from the textbook and research papers. The goals of this course are to understand how large-scale computational systems are built, and to provide students with the tools necessary to evaluate new technologies after the course ends.

Requirements/Evaluation: weekly homework assignments, midterm exam, 3 major programming projects, and a final project
Prerequisites: CSCI 237
Enrollment Limit: 24
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024

CSCI 345 (S) Robotics and Digital Fabrication (QFR)

This course is a hands-on exploration of topics in robotics and digital fabrication. We will experience firsthand how ideas and methods from computer science can be applied to make physical objects, including robots and other machines. The emphasis will be on creative, hands-on experimentation. Along the way, students will learn the basics of embedded systems programming (Arduino), breadboarding, soldering, printed circuit board (PCB) design, mechanical computer-aided design (CAD)--both conventional (OnShape) and programmatic (OpenSCAD)--as well digital fabrication (3D-printing, laser cutting). Students will learn both how to build their own prototypes and how to send out designs to have parts machined professionally. Students will work in teams throughout. The course will culminate in a team robotic design competition testing both functionality and creativity.

Requirements/Evaluation: Evaluation based on assignments, projects, and exams.
Prerequisites: CSCI 237
Enrollment Limit: 18; 9/lab
Enrollment Preferences: Current or expected Computer Science majors
Expected Class Size: 18
Grading: no pass/fail option, no fifth course option
Materials/Lab Fee: A fee of $150-$200 will be added to the term bill to cover the purchase of consumable electronics, motors, 3D-printing filament, and stock used in the assignments and final project.
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: The course will include programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025

LEC Section: 01  TR 9:55 am - 11:10 am  James M. Bern
LAB Section: 03  T 2:30 pm - 4:00 pm  James M. Bern
LAB Section: 02  T 1:00 pm - 2:30 pm  James M. Bern
CSCI 357 (S) Algorithmic Game Theory (QFR)

This course focuses on topics in game theory and mechanism design from a computational perspective. We will explore questions such as: how to design algorithms that incentivize truthful behavior, that is, where the participants have no incentive to cheat? Should we let drivers selfishly minimize their commute time or let a central algorithm direct traffic? Does Arrow's impossibility result mean that all voting protocols are doomed? The overarching goal of these questions is to understand and analyze selfish behavior and whether it can or should influence system design. Students will learn how to model and reason about incentives in computational systems both theoretically and empirically. Topics include types of equilibria, efficiency of equilibria, auction design and mechanism design with money, two-sided markets and mechanism design without money, incentives in computational applications such as P2P systems, and computational social choice.

Requirements/Evaluation: weekly problem sets and/or programming assignments, two midterm exams, and a final project.

Prerequisites: CSCI 256

Enrollment Limit: 24

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist problem sets and programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Spring 2025

LEC Section: 01  TF 1:10 pm - 2:25 pm  Shikha Singh

CSCI 358 (F) Applied Algorithms (QFR)

This course is about bridging the gap between theoretical running time and writing fast code in practice. The course is divided into two basic topics. The first is algorithmic: we will discuss some of the most useful tools in a coder's toolkit. This includes topics like randomization (hashing, filters, approximate counters), linear and convex programming, similarity search, and cache-efficient algorithms. Our goal is to talk about why these efficient algorithms make seemingly difficult problems solvable in practice. The second topic is applications: we will discuss how to implement algorithms in an efficient way that takes advantage of modern hardware. Specific topics covered will include blocking, loop unrolling, pipelining, as well as strategies for performance analysis. Projects and assessments will include both basic theoretical aspects (understanding why the algorithms we discuss actually work), and practical aspects (implementing the algorithms we discuss to solve important problems, and optimizing the code so it runs as quickly as possible).

Requirements/Evaluation: Over the course of each week, there will be either a homework or an assignment. Homeworks and assignments have similar structure, with both a coding and problem set component, but assignments will be weighted more heavily and must be completed individually. There will also be a take home final at the end of the year.

Prerequisites: CSCI 256 and CSCI 237

Enrollment Limit: 24

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2024

LEC Section: 01  TF 1:10 pm - 2:25 pm  Samuel McCauley

CSCI 361 (F) Theory of Computation (QFR)

Cross-listings: MATH 361
This course introduces a formal framework for investigating both the computability and complexity of problems. We study several models of computation including finite automata, regular languages, context-free grammars, and Turing machines. These models provide a mathematical basis for the study of computability theory—the examination of what problems can be solved and what problems cannot be solved—and the study of complexity theory—the examination of how efficiently problems can be solved. Topics include the halting problem and the P versus NP problem.

Requirements/Evaluation: weekly problem sets and one or more exams
Prerequisites: CSCI 256 or both a 300-level MATH course and permission of instructor
Enrollment Limit: 24
Enrollment Preferences: current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
MATH 361(D3) CSCI 361(D3)

Quantitative/Formal Reasoning Notes: This course includes regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.
Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01 TR 8:30 am - 9:45 am Shikha Singh
LEC Section: 02 TR 9:55 am - 11:10 am Shikha Singh

CSCI 375 (F) Natural Language Processing (QFR)
Natural language processing (NLP) is a set of methods for making human language accessible to computers. NLP underlies many technologies we use on a daily basis including automatic machine translation, search engines, email spam detection, and automated personalized assistants. These methods draw from a combination of algorithms, linguistics and statistics. This course will provide a foundation in building NLP models to classify, generate, and learn from text data.
Requirements/Evaluation: Evaluation based on assignments, projects, and exams.
Prerequisites: CSCI 136, and either CSCI 256 or STAT 201/202.
Enrollment Limit: 24
Enrollment Preferences: current or expected Computer Science majors.
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.
Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01 TR 9:55 am - 11:10 am Katie A. Keith

CSCI 381 (F) Deep Learning (QFR)
This course is an introduction to deep neural networks and how to train them. Beginning with the fundamentals of regression and optimization, the course then surveys a variety of neural network architectures, which may include multilayer feedforward neural networks, convolutional neural networks, recurrent neural networks, and transformer networks. Students will also learn how to use deep learning software such as PyTorch or Tensorflow.
Requirements/Evaluation: Evaluation based on assignments, projects, and exams.
Prerequisites: CSCI 136 and fulfillment of the Discrete Mathematics Proficiency requirement
Enrollment Limit: 24
Enrollment Preferences: Current or expected Computer Science majors
Expected Class Size: 24
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: The course will consist of programming assignments and problem sets in which quantitative/formal reasoning skills are practiced and evaluated.
Attributes: COGS Interdepartmental Electives

Fall 2024
LEC Section: 01 MWF 9:00 am - 9:50 am Mark Hopkins

ECON 110 (F)(S) Principles of Microeconomics (QFR)
This course is an introduction to the study of the forces of supply and demand that determine prices and the allocation of resources in markets for goods and services, markets for labor, and markets for natural resources. The focus is on how and why markets work, why they may fail to work, and the policy implications of both their successes and failures. The course focuses on developing the basic tools of microeconomic analysis and then applying those tools to topics of popular or policy interest such as minimum wage legislation, pollution control, competition policy, international trade policy, discrimination, tax policy, and the role of government in a market economy.
Requirements/Evaluation: problem sets, quizzes, short essays, two midterms, final exam
Prerequisites: none
Enrollment Limit: 40
Enrollment Preferences: This course is required of Economics and Political Economy majors and highly recommended for those non-majors interested in Environmental Studies and Women's, Gender and Sexuality Studies.
Expected Class Size: 40
Grading: yes pass/fail option, no fifth course option
Unit Notes: The department recommends students follow this course with ECON 120 or with a lower-level elective that has ECON 110 as its prerequisite; students may alternatively proceed directly to ECON 251 after taking this introductory course.
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: Course involves mathematical modeling of real-world phenomena, analyzing quantitative results, and describing those results in words.
Attributes: POEC Required Courses

Fall 2024
LEC Section: 06 MWF 11:00 am - 12:15 pm Nate Vellekoop
LEC Section: 01 TF 1:10 pm - 2:25 pm Matthew Chao
LEC Section: 02 TF 2:35 pm - 3:50 pm Matthew Chao
LEC Section: 03 TR 11:20 am - 12:35 pm Susan Godlonton
LEC Section: 04 TR 9:55 am - 11:10 am Owen Thompson
LEC Section: 05 MWF 8:30 am - 9:45 am Nate Vellekoop

Spring 2025
LEC Section: 02 TF 2:35 pm - 3:50 pm Ethan Holdahl
LEC Section: 01 TF 1:10 pm - 2:25 pm Ethan Holdahl
ECON 120 (F)(S) Principles of Macroeconomics (QFR)

This course provides an introduction to the study of the aggregate national economy. It develops the basic theories of macroeconomics and applies them to topics of current interest. Issues to be explored include: the causes of inflation, unemployment, recessions, and depressions; the role of government fiscal and monetary policy in stabilizing the economy; the determinants of long-run economic growth; the long- and short-run effects of taxes, budget deficits, and other government policies on the national economy; the role of financial frictions in amplifying recessions; and the workings of exchange rates and international finance.

Requirements/Evaluation: Depending on instructor, may include: problem sets, short essays, quizzes, reading assignments, either one or two midterms, and a final exam.

Prerequisites: ECON 110

Enrollment Limit: 40

Enrollment Preferences: First-year students and sophomores.

Expected Class Size: 40

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: Course involves mathematical modeling of real-world phenomena, analyzing quantitative results, and describing those results in words.

Attributes: POEC Required Courses

Fall 2024
LEC Section: 02 TR 9:55 am - 11:10 am David A. Love
LEC Section: 01 MWF 11:00 am - 12:15 pm Bumsoo Kim

Spring 2025
LEC Section: 03 TR 11:20 am - 12:35 pm Bumsoo Kim
LEC Section: 01 MR 1:10 pm - 2:25 pm Caitlin E. Hegarty
LEC Section: 04 MWF 11:00 am - 12:15 pm David A. Love
LEC Section: 05 TR 8:30 am - 9:45 am Will Olney
LEC Section: 02 MR 2:35 pm - 3:50 pm Caitlin E. Hegarty

ECON 213 (S) Introduction to Environmental and Natural Resource Economics (QFR)

Cross-listings: ENVI 213 / CAOS 213

Primary Cross-listing

We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

Requirements/Evaluation: problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)

Prerequisites: ECON 110 or equivalent

Enrollment Limit: 30

Enrollment Preferences: first-year and sophomore students

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Unit Notes: this course will count toward both the Environmental Studies major and concentration

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ECON 213(D2) ENVI 213(D2) CAOS 213(D2)

Quantitative/Formal Reasoning Notes: We will use formal theory expressed in math and graphs, perform calculations, and consume statistical data.

Attributes: ENVI Environmental Policy EVST Social Science/Policy POEC Depth

Spring 2025

LEC Section: 01 MWF 8:30 am - 9:45 am Sarah A. Jacobson

ECON 229 (F) Law and Economics (QFR)

This course applies the tools of microeconomic analysis to private (i.e., civil) law. This analysis has both positive and normative aspects. The positive aspects deal with how individuals respond to the incentives created by the legal system. Examples include: how intellectual property law encourages the creation of knowledge while simultaneously restricting the dissemination of intellectual property; how tort law motivates doctors to avoid malpractice suits; and how contract law facilitates agreements. The normative aspects of the analysis ask whether legal rules enhance economic efficiency (or, more broadly, social welfare). Examples include: what legal rules are most appropriate for mitigating pollution, ensuring safe driving, and guaranteeing workplace safety? The course will also cover the economics of legal systems; for example, what are the incentives for plaintiffs to initiate lawsuits and what role do lawyers play in determining outcomes.

Class Format: discussion

Requirements/Evaluation: class participation, problem sets, paper based on actual court cases, a midterm exam, and a final exam

Prerequisites: ECON 110

Enrollment Limit: 35

Enrollment Preferences: ECON and POEC majors (and potential majors) will receive priority if the course is overenrolled

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: This course uses economic models to explore the logic of legal concepts. While some arguments will be qualitative, students will also use numerical examples to illustrate the principles of the course.

Attributes: JLST Interdepartmental Electives POEC Depth

Fall 2024

SEM Section: 01 W 7:00 pm - 9:40 pm William M. Gentry

ECON 232 (S) Financial Markets, Institutions and Policies (QFR)

The focus of the course will be on how firms, financial markets, and central banks interact in the economy. Key questions addressed in the course include: How do firms allocate their resources to enhance their value? How are firms evaluated by the financial markets? How are asset prices determined, and how are these prices related to interest rates? Are financial markets efficient, and what are the implications of their efficiency or lack thereof? How does the financial system help with the management of risks faced by society? We will also study the role of the central bank (the Federal Reserve in the US), monetary policy, and government regulation and their impacts on financial decision making. Key questions include: How do central banks set monetary policy and how do those policies affect the economy and the financial decision-making process? How does monetary policy change when interest rates are (virtually) zero?

Class Format: There will be a mix of lecture and discussion.

Requirements/Evaluation: 5-7 Problem Sets, Quantitative Exercises, Group Paper, and Final Exam

Prerequisites: ECON 110 and ECON 120

Enrollment Limit: 25

Enrollment Preferences: Sophomore and Junior Economics majors

Expected Class Size: 25

Grading: yes pass/fail option, no fifth course option

Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: We will use mathematical models, graphs, and data analysis to understand financial decisions at the firm and economy-wide levels.

Attributes: POEC Depth

Spring 2025
LEC Section: 01   TR 11:20 am - 12:35 pm   Nate Vellekoop

ECON 251  (F)(S)  Price and Allocation Theory  (QFR)
A study of the determination of relative prices and their importance in shaping the allocation of resources and the distribution of income. Subjects include: behavior of households in a variety of settings, such as buying goods and services, saving, and labor supply; behavior of firms in various kinds of markets; results of competitive and noncompetitive markets in goods, labor, land, and capital; market failure; government policies as sources of and responses to market failure; welfare criteria; limitations of mainstream analysis.

Requirements/Evaluation: Requirements vary by professor, but typically include frequent problem sets and multiple exams, including a final exam. They may also include one or more quizzes, short essays, collaborative projects, or presentations.
Prerequisites: ECON 110 and MATH 130 or its equivalent
Enrollment Limit: 30
Enrollment Preferences: Current or prospective Economics majors.
Expected Class Size: 30
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2)  (QFR)

Quantitative/Formal Reasoning Notes: Course involves developing and analyzing mathematical models of real-world phenomena, grounded in tools like calculus and game theory. Students are assumed to be comfortable with topics from introductory calculus, including differentiation and integration.

Fall 2024
LEC Section: 03   TF 1:10 pm - 2:25 pm   Ethan Holdahl
LEC Section: 01   MR 1:10 pm - 2:25 pm   Greg Phelan
LEC Section: 02   MR 2:35 pm - 3:50 pm   Greg Phelan

Spring 2025
LEC Section: 01   TR 9:55 am - 11:10 am   Greg Phelan
LEC Section: 02   MR 1:10 pm - 2:25 pm   Sara LaLumia
LEC Section: 03   MR 2:35 pm - 3:50 pm   Sara LaLumia

ECON 252  (F)(S)  Macroeconomics  (QFR)
A study of aggregate economic activity: output, employment, inflation, and interest rates. The class will develop a theoretical framework for analyzing economic growth and business cycles. The theory will be used to evaluate policies designed to promote growth and stability, and to understand economic developments in the U.S. and abroad. Instructors may use elementary calculus in assigned readings, exams and lectures.

Requirements/Evaluation: Requirements vary by professor, but typically include frequent problem sets and/or written assignments, midterm(s), and a final exam.
Prerequisites: ECON 110 and 120 and MATH 130 or its equivalent
Enrollment Limit: 30
Enrollment Preferences: Current or prospective Economics majors.
Expected Class Size: 30
Grading: yes pass/fail option, no fifth course option
Distributions: (D2)  (QFR)

Quantitative/Formal Reasoning Notes: Course involves mathematical modeling of real-world phenomena, analyzing quantitative results, and describing those results in words.
ECON 255  (F)(S)  Econometrics  (QFR)
An introduction to the theory and practice of applied quantitative economic analysis. This course familiarizes students with the strengths and weaknesses of the basic empirical methods used by economists to evaluate economic theory against economic data. Emphasizes both the statistical foundations of regression techniques and the practical application of those techniques in empirical research, with a focus on understanding when a causal interpretation is warranted. Computer exercises will provide experience in using the empirical methods, but no previous computer experience is expected. Highly recommended for students considering graduate training in economics or public policy.

Requirements/Evaluation:  Requirements vary by professor, but typically include frequent problem sets, multiple exams, a group project, and possible additional assignments or quizzes.

Prerequisites:  MATH 130, plus STAT 161, 201 or 202 (or equivalent, including a score of 5 on the AP Statistics Exam), plus one course in ECON; STAT 101 will also serve as a prerequisite, but only if taken prior to the fall of 2018

Enrollment Limit:  30

Enrollment Preferences:  Current or prospective Economics and Political Economy majors.

Expected Class Size:  30

Grading:  no pass/fail option,  no fifth course option

Unit Notes:  Students may substitute the combination of STAT 201 and 346 for ECON 255

Distributions:  (D2)  (QFR)

Quantitative/Formal Reasoning Notes:  Course teaches research tools necessary to analyze data.

Attributes:  POEC Required Courses

ECON 345  (S)  Growth Diagnostics  (QFR)
Cross-listings:

Evidence from across the developing world suggests that the "binding constraints" to economic growth can be remarkably heterogeneous—i.e., the growth potential of stagnating or underperforming economies may be unlocked in a large variety of ways. For instance, pre-reform China had been constrained by poor supply incentives in agriculture, whereas Brazil has been held back by an inadequate supply of credit, South Africa by poor employment incentives in manufacturing, El Salvador by insufficient production incentives in tradables, Zimbabwe by bad governance, and so forth.

How can developing-country policymakers determine country-specific constraints like these, thus enabling them to pragmatically pursue a selected set of growth-promoting policies rather than attempting to implement a "laundry list" of reforms that are naively based on "best practice" rules-of-thumb?
This course will serve as a primer on "growth diagnostics," an empirically-driven analytical framework for identifying the most binding constraints to economic growth in a given country at a point in time, thereby allowing policymakers to develop well-targeted reforms for relaxing these constraints while being cognizant of the nation's prevailing economic, political, and social context. The course will first build on the basic theories and empirics of economic growth to elucidate the diagnostic framework and will then employ a wide range of country-specific case studies to demonstrate how the framework can be operationalized for policy making. Throughout the semester, students will be required to work in groups, each representing a given developing or emerging-market economy, in order to build a growth diagnostic for their group's assigned country by the end of the course.

Requirements/Evaluation: extensive class participation, several short (5-page) reports, a final group project comprising a country growth diagnostic, and a final group presentation on the diagnostic

Prerequisites: for undergraduates ECON 251, ECON 252, and either ECON 255 or STAT 346

Enrollment Limit: 19

Enrollment Preferences: CDE fellows and senior Economics majors

Expected Class Size: 19

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

ECON 345(D2) ECON 545(D2)

Quantitative/Formal Reasoning Notes: The course material will be draw heavily on mathematical and statistical models of economic growth and macroeconomic development, and students will be required to routinely develop mathematical models and/or conduct econometric analysis in their assignments.

Spring 2025

SEM Section: 01   TR 9:55 am - 11:10 am   Quamrul H. Ashraf

ECON 364  (S)  Theory of Asset Pricing  (QFR)

What is the price of time? What is the price of risk? How do markets allocate resources across time and uncertain states of the world? This course theoretically studies how markets allocate scarce resource across time and when outcomes are risky. The "goods" in such markets are called "assets" and the prices of "assets" determine the cost of trading resources across time and across uncertain states of the world. We theoretically investigate how equilibrium determines the price of time, then asset price implications; then asset allocations and prices in the presence of risk; finally, implications for new assets.

Requirements/Evaluation: problem sets and exams

Prerequisites: ECON 251 or ECON 252; and ECON 255 or STAT 201

Enrollment Limit: 25

Enrollment Preferences: Economics majors

Expected Class Size: 25

Grading: no pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: uses extensive mathematical modeling, including engaging with results from econometrics and statistics

Spring 2025

LEC Section: 01   TR 8:30 am - 9:45 am   Greg Phelan

ECON 367  (S)  The Political Economy of Social Insurance   (WS) (QFR)

The Great Society policies of the 1960s dramatically changed the ways people living in poverty interacted with the federal government, but the benefits associated with these policies seem to have stagnated. Since 1965, the annual poverty rate in the United States has hovered between 10% and 15%, though far more than 15% of Americans experience poverty at some point in their lives. In this course, we will study public policies that, explicitly or implicitly, have as a goal improving the well-being of the poor in the United States. These policies include social insurance programs such as Unemployment Insurance; safety net programs such as Temporary Assistance to Needy Families, Supplemental Nutrition Assistance Program,
Medicaid, and housing assistance; education programs such as Head Start and public education; and parts of the tax code, including the Earned Income Tax Credit and Child Tax Credit. We will explore the design and function of these programs, with a particular focus on the context in which they were developed. What political incentives and constraints have strung up our social safety net? How do these factors affect the goals of policy, the trade-offs inherent to the policy’s design, and why poverty has not sustained a downward trend in the United States? Through careful consideration, students will learn how to communicate a path forward for public policy which accounts for theoretical economic expectations and the reality of political constraints in policy design.

Class Format: Lecture with substantial class discussion.

Requirements/Evaluation: Several short policy memos, participation in class discussion, and a final analytical essay.

Prerequisites: ECON 253 or 255

Enrollment Limit: 25

Enrollment Preferences: Students majoring in economics or political economy.

Expected Class Size: 25

Grading: no pass/fail option, yes fifth course option

Distributions: (D2) (WS) (QFR)

Writing Skills Notes: Students will write 4 policy memos over the course of the semester followed by a longer, final analytical essay. Synthesis of peer-reviewed literature, use of citation management systems, and clarity in technical writing will be emphasized. Students will receive timely, substantial, individualized feedback to develop their technical writing ability over the course of the semester. Opportunities to meet with professor outside of class at any stage of writing.

Quantitative/Formal Reasoning Notes: This course will use quantitative tools of economics. Focus on building data visualization & science communication skills after ECON 255.

Attributes: POEC Skills

Spring 2025
LEC Section: 01  TF 2:35 pm - 3:50 pm  Shyam Raman

ECON 371 (F) Time Series Econometrics and Empirical Methods for Macro (QFR)

Econometric methods in many fields including macro and monetary economics, finance and international growth and development, as well as numerous fields beyond economics, have evolved a distinct set of techniques which are designed to meet the practical challenges posed by the typical empirical questions and available time series data of these fields. The course will begin with an introductory review of concepts of estimation and inference for large data samples in the context of the challenges of multivariate endogenous systems, and will then focus on associated methods for analysis of short run dynamics such as vector autoregressive techniques and methods for analysis of long run dynamics such as cointegration techniques. Students will be introduced to concepts and techniques analytically, but also by intuition, learning by doing, and by computer simulation and illustration. The course is particularly well suited for economics majors wishing to explore advanced empirical methods, or for statistics, mathematics or computer science majors wishing to learn more about the ways in which the subject of their majors interacts with the field of economics. The method of evaluation will include a term paper. ECON 252 and either STATS 346 or ECON 255 are formal prerequisites, although for students with exceptionally strong math/stats backgrounds these can be waived subject to instructor permission. Students who complete this course will also be permitted to enroll in Econ 471 (a follow up senior seminar course) during the spring semester if they are interested.

Requirements/Evaluation: term paper and regular homework assignments

Prerequisites: ECON 252 and either ECON 255 or STATS 346

Enrollment Limit: 19

Enrollment Preferences: students wishing to write an honors thesis, and students with strong MATH/STAT/CSCI backgrounds

Expected Class Size: 19

Grading: no pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: Uses quantitative/formal reasoning intensively in the form of mathematical and statistical arguments, as well as computer programming.
ECON 384 (F) Corporate Finance (QFR)
This course analyzes the major financial decisions facing firms. While the course takes the perspective of a manager making decisions about both what investments to undertake and how to finance these projects, it will emphasize the underlying economic models that are relevant for these decisions. Topics include capital budgeting, links between real and financial investments, capital structure choices, dividend policy, and firm valuation.

Class Format: Lecture / discussion
Requirements/Evaluation: Problem sets, exams, short project
Prerequisites: ECON 251, 252, and some familiarity with statistics (e.g., ECON 255)
Enrollment Limit: 25
Enrollment Preferences: Economics majors; seniority
Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: The course uses quantitative models to evaluate decisions.

ECON 385 (F) Games and Information (QFR)
This course is a mathematical introduction to strategic thinking and its applications. Ideas from game theory, including Nash equilibrium and its refinements, commitment and credibility, repeated games, and information asymmetries, incentive contracts, and signaling, will be introduced. Applications will be drawn from economics, history, and politics around the globe, and include topics such as: trust between strangers, corruption and fraud, racial bias, violence and deterrence. And we will explore how to write and recognize game-theory models to help make sense of strategic interactions in the world around us.

Requirements/Evaluation: Two exams, regular problem sets and assignments in which students create game-theoretic models.
Prerequisites: ECON 251 or permission of instructor
Enrollment Limit: 25
Enrollment Preferences: juniors
Expected Class Size: 25
Grading: no pass/fail option, no fifth course option
Unit Notes: students who have taken MATH 335 or CSCI 357 cannot receive credit for this class
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: Mathematical analysis of strategic interaction is emphasized throughout.

ECON 389 (S) Tax Policy in Global Perspective (QFR)
Cross-listings:
Secondary Cross-listing
Government policy is important for economic development. To finance their policies, governments must build the fiscal capacity to implement a tax system. In turn, fiscal capacity—the ability for the government to raise revenue—depends on economic development. This endogeneity between fiscal capacity and economic development creates challenges for tax policy in developing countries. Given these challenges, what types of taxes should
countries use to raise revenues? How can governments build the fiscal capacity to generate revenue to finance critical services? This class explores tax policy from a global and comparative perspective. Because most students will be CDE fellows, we will emphasize tax policy issues, examples, and evidence that are pertinent to developing countries. However, many tax policy lessons are universal so we will also learn about tax policies in developed countries, especially issues relevant for transnational transactions. Topics addressed include: how economic principles can be applied to the efficiency and equity consequences of tax policies; how personal income taxes, corporate income taxes, and value-added taxes are designed and administered and how they influence the economy; ideas for fundamental tax reforms; the debate over progressive taxes versus "flat" taxes; how taxes affect incentives to save and invest; how market failures and administrative problems may influence the optimality of tax policy; the implications of global capital flows and corporate tax avoidance for tax policy; tax holidays and other special tax incentives for investment; empirical evidence on the influence of taxes on foreign direct investment, labor supply, and tax evasion; tax policy towards natural resources such as minerals and oil; case studies of efforts to reform tax administration and reduce tax evasion and corruption; taxes on land and property; taxes on imports and exports; presumptive taxation; and the informal economy and its implications for tax policy.

Requirements/Evaluation: midterm exam, several problem sets, two 10-page essays
Prerequisites: one public economics course or microeconomics course (ECON 504 or ECON 110), and one empirical methods course (POEC 253 or ECON 255, 502, or 503); students who have previously taken ECON 351 will not be enrolled
Enrollment Limit: 19
Enrollment Preferences: CDE students, but undergraduates with the prerequisites are welcome
Expected Class Size: 15-19
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
ECON 389(D2) ECON 514(D2)
Quantitative/Formal Reasoning Notes: The course builds on other QFR Reasoning econ classes.
Attributes: POEC Depth POEC Skills

Spring 2025
SEM Section: 01 MR 2:35 pm - 3:50 pm Jon M. Bakija

ECON 454 (F) Macroeconomic Perspectives on Labor Markets (QFR)
This seminar will cover aggregate trends in the labor market from a macroeconomic perspective, along with the tools that economists use to study them. We will think about the workforce as a whole but we will also highlight research that studies heterogeneity within the economy, such as patterns by race, gender, education, or occupation. Students will learn basic search and matching models, as well as related empirical methods. We will read papers that employ a variety of survey and administrative data, and we will discuss what types of research questions are best answered by each data source. We will use real data to apply the methods we learn. Potential topics include occupational mismatch, wage inequality, and monopsony.
Requirements/Evaluation: Class participation, short assignments, midterm exam, and a final project
Prerequisites: Econ 251, 252, and 255
Enrollment Limit: 19
Enrollment Preferences: Junior and senior economics majors
Expected Class Size: 19
Grading: no pass/fail option, yes fifth course option
Distributions: (D2) (QFR)
Quantitative/Formal Reasoning Notes: Course includes regular problem sets that require quantitative and formal reasoning skills.

Fall 2024
SEM Section: 01 MWF 8:30 am - 9:45 am Caitlin E. Hegarty

ECON 471 (S) Topics in Advanced Econometrics (QFR)
The course uses both a practical and conceptual/theory based approach, with emphasis on methods of structural identification of dynamics in VARs
and long run cointegration and nonlinear function estimation and analysis, both in conventional time series and especially panel time series which contain spatial dimensions. The course will also investigate methods of computer simulation related to these techniques. The course is well suited for students considering empirically oriented honors theses in fields that employ these techniques, such as macro, finance, growth, trade and development, as well as fields outside of economics that use time series data. It is also well suited for students majoring in economics, statistics, computer sciences or mathematics who wish to expand their econometrics training and understanding to a more advanced level.

**Requirements/Evaluation:** periodic homework assignments, term paper

**Prerequisites:** ECON 371

**Enrollment Limit:** 19

**Enrollment Preferences:** students with strong quantitative backgrounds, and to students intending to write an honors thesis

**Expected Class Size:** 19

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** Course will make use of mathematics, statistics and computer analysis for the conceptualization and implementation of the econometric topics that are taught.

Spring 2025

SEM Section: 01  W 7:00 pm - 9:40 pm  Peter L. Pedroni

**ECON 477 (F) Economics of Environmental Behavior (QFR)**

**Cross-listings:** CAOS 477 / ENVI 376

**Primary Cross-listing**

A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.

**Class Format:** Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities

**Requirements/Evaluation:** class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory

**Prerequisites:** ECON 251 and (ECON 255 or STAT 346)

**Enrollment Limit:** 19

**Enrollment Preferences:** senior Economics majors and junior Economics majors considering a thesis

**Expected Class Size:** 19

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

CAOS 477(D2) ENVI 376(D2) ECON 477(D2)

**Quantitative/Formal Reasoning Notes:** The research students will consume and produce in the class will be based on math-based theory and/or econometric-based empirical analysis.

**Attributes:** CAOS Senior Seminars  ENVI Humanities, Arts + Social Science Electives  POEC Depth  POEC Skills

Fall 2024

SEM Section: 01  TR 8:30 am - 9:45 am  Sarah A. Jacobson
ECON 514 (S) Tax Policy in Global Perspective (QFR)

Cross-listings:

Primary Cross-listing

Government policy is important for economic development. To finance their policies, governments must build the fiscal capacity to implement a tax system. In turn, fiscal capacity—the ability for the government to raise revenue—depends on economic development. This endogeneity between fiscal capacity and economic development creates challenges for tax policy in developing countries. Given these challenges, what types of taxes should countries use to raise revenues? How can governments build the fiscal capacity to generate revenue to finance critical services? This class explores tax policy from a global and comparative perspective. Because most students will be CDE fellows, we will emphasize tax policy issues, examples, and evidence that are pertinent to developing countries. However, many tax policy lessons are universal so we will also learn about tax policies in developed countries, especially issues relevant for transnational transactions. Topics addressed include: how economic principles can be applied to the efficiency and equity consequences of tax policies; how personal income taxes, corporate income taxes, and value-added taxes are designed and administered and how they influence the economy; ideas for fundamental tax reforms; the debate over progressive taxes versus "flat" taxes; how taxes affect incentives to save and invest; how market failures and administrative problems may influence the optimality of tax policy; the implications of global capital flows and corporate tax avoidance for tax policy; tax holidays and other special tax incentives for investment; empirical evidence on the influence of taxes on foreign direct investment, labor supply, and tax evasion; tax policy towards natural resources such as minerals and oil; case studies of efforts to reform tax administration and reduce tax evasion and corruption; taxes on land and property; taxes on imports and exports; presumptive taxation; and the informal economy and its implications for tax policy.

Requirements/Evaluation: midterm exam, several problem sets, two 10-page essays

Prerequisites: one public economics course or microeconomics course (ECON 504 or ECON 110), and one empirical methods course (POEC 253 or ECON 255, 502, or 503); students who have previously taken ECON 351 will not be enrolled

Enrollment Limit: 19

Enrollment Preferences: CDE students, but undergraduates with the prerequisites are welcome

Expected Class Size: 15-19

Grading: yes pass/fail option, yes fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ECON 389(D2) ECON 514(D2)

Quantitative/Formal Reasoning Notes: The course builds on other QFR Reasoning econ classes.

Attributes: POEC Depth POEC Skills

Spring 2025

SEM Section: 01 MR 2:35 pm - 3:50 pm Jon M. Bakija

ECON 545 (S) Growth Diagnostics (QFR)

Cross-listings:

Secondary Cross-listing

Evidence from across the developing world suggests that the "binding constraints" to economic growth can be remarkably heterogeneous—i.e., the growth potential of stagnating or underperforming economies may be unlocked in a large variety of ways. For instance, pre-reform China had been constrained by poor supply incentives in agriculture, whereas Brazil has been held back by an inadequate supply of credit, South Africa by poor employment incentives in manufacturing, El Salvador by insufficient production incentives in tradables, Zimbabwe by bad governance, and so forth. How can developing-country policymakers determine country-specific constraints like these, thus enabling them to pragmatically pursue a selected set of growth-promoting policies rather than attempting to implement a "laundry list" of reforms that are naively based on "best practice" rules-of-thumb? This course will serve as a primer on "growth diagnostics," an empirically-driven analytical framework for identifying the most binding constraints to economic growth in a given country at a point in time, thereby allowing policymakers to develop well-targeted reforms for relaxing these constraints while being cognizant of the nation's prevailing economic, political, and social context. The course will first build on the basic theories and empirics of economic growth to elucidate the diagnostic framework and will then employ a wide range of country-specific case studies to demonstrate how the framework can be operationalized for policy making. Throughout the semester, students will be required to work in groups, each representing a given developing or emerging-market economy, in order to build a growth diagnostic for their group's assigned country by the end of the course.
Requirements/Evaluation: extensive class participation, several short (5-page) reports, a final group project comprising a country growth diagnostic, and a final group presentation on the diagnostic

Prerequisites: for undergraduates ECON 251, ECON 252, and either ECON 255 or STAT 346

Enrollment Limit: 19

Enrollment Preferences: CDE fellows and senior Economics majors

Expected Class Size: 19

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ECON 345(D2) ECON 545(D2)

Quantitative/Formal Reasoning Notes: The course material will be draw heavily on mathematical and statistical models of economic growth and macroeconomic development, and students will be required to routinely develop mathematical models and/or conduct econometric analysis in their assignments.

Spring 2025
SEM Section: 01 TR 9:55 am - 11:10 am Quamrul H. Ashraf

ENVI 108 (S) Energy Science and Technology (QFR)

Cross-listings: PHYS 108

Secondary Cross-listing

Energy use has skyrocketed in the United States and elsewhere in the world, causing significant economic and political shifts, as well as concerns for the environment. This course will address the physics and technology of energy generation, consumption, and conservation. It will cover a wide range of energy sources, including fossil fuels, hydropower, solar energy, wind energy, and nuclear energy. We will discuss energy use in transportation, manufacturing, building heating and lighting, and energy storage. Students will learn to compare the efficiencies and environmental impacts of various energy sources and uses.

Class Format: Two meetings per week. Some weeks that means two lectures. Other weeks, that means one lecture plus one lab, with the class divided between two lab sections.

Requirements/Evaluation: weekly assignments, two hour tests, and a final project culminating in an oral presentation to the class and a 10-page paper; all of these will be substantially quantitative

Prerequisites: high school physics, high school chemistry, and mathematics at the level of MATH 130

Enrollment Limit: 10 per lab

Enrollment Preferences: non-physics majors

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 108(D3) PHYS 108(D3)

Quantitative/Formal Reasoning Notes: problems sets, exams, and projects will all have a quantitative aspects.

Attributes: ENVI Natural World Electives

Spring 2025
LAB Section: 03 R 2:25 pm - 3:50 pm Protik K. Majumder
LEC Section: 01 MR 1:10 pm - 2:25 pm Protik K. Majumder
LAB Section: 02 R 1:10 pm - 2:25 pm Protik K. Majumder

ENVI 203 (F) Ecology (QFR)
Cross-listings: BIOL 203

Secondary Cross-listing

This course combines lectures & discussion with field and indoor laboratory activities to explore factors that determine the distribution and abundance of plants and animals in natural systems. The course begins with an overview of global environmental patterns and then builds from the population to ecosystem level. Throughout the course, we will emphasize the connection between basic ecological principles and current environmental issues. Selected topics include population dynamics (competition, predation, mutualism); community interactions (succession, food chains and diversity) and ecosystem function (biogeochemical cycles, energy flow). Laboratory activities are designed to engage students in the natural history of the region and build skills in data analysis and scientific writing.

Requirements/Evaluation: pre-class quizzes, lab reports, two mid-term exams, and a final exam

Prerequisites: BIOL 102, or ENVI 102, or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: students planning to pursue Biology and/or ENVI

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

BIOL 203(D3) ENVI 203(D3)

Quantitative/Formal Reasoning Notes: Much of the material in this course centers on the interpretation and application of mathematical models used to describe ecological systems. The laboratory section of this course also contains a large data analysis component (based in R). Students are introduced to linear models, multidimensional data analysis and contingency tables.

Attributes: ENVI Natural World Electives EVST Environmental Science

Fall 2024

LAB Section: 03  W 1:00 pm - 3:50 pm  Manuel A. Morales

LAB Section: 02  T 1:00 pm - 3:50 pm  Manuel A. Morales

LEC Section: 01  TR 8:30 am - 9:45 am  Manuel A. Morales

ENVI 213 (S) Introduction to Environmental and Natural Resource Economics (QFR)

Cross-listings: ECON 213 / CAOS 213

Secondary Cross-listing

We'll use economics to provide one perspective on reasons humans harm the environment and overuse natural resources, and what we can do about it. We'll study climate change, pollution in general, cost benefit analysis, environmental justice, natural resources (like fisheries, forests, and fossil fuels), and energy. We'll talk about how economists put a dollar value on nature and ecosystem services (as well as human health and life!), and the concerns people may have about doing so. We will take an economic approach to global sustainability, and study the relationship between the environment and economic growth. Consideration of justice and equity will be woven throughout the whole semester.

Requirements/Evaluation: problem sets, short essays, final paper; intermediate assignments may include a poster, one or more short presentation(s), other brief writing assignment(s)

Prerequisites: ECON 110 or equivalent

Enrollment Limit: 30

Enrollment Preferences: first-year and sophomore students

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Unit Notes: this course will count toward both the Environmental Studies major and concentration

Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces—wind, waves, storms, and people—that shape the coastal zone, as well as the geologic formations—sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs—that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change. Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week

Requirements/Evaluation: lab reports, quizzes, and an independent research project

Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.

Enrollment Limit: 15

Enrollment Preferences: Geosciences majors

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option

Unit Notes: This course counts toward the GEOS Group B Electives - Sediments + Life.

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 327(D3) GEOS 327(D3) CAOS 327(D3)

Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.

Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life
A community maintains a fishery; a firm decides whether to get a green certification; you choose to fly home or stay here for spring break: behaviors of people and firms determine our impact on the environment. We'll use economics to model environmental behavior and to assess how policies can help or hurt the environment. Topics we may study include: common pool resources, voluntary conservation, social norms and nudges, discrimination and justice, rationality, firm responses to mandatory and voluntary regulation, voting and public opinion, and international environmental agreements. We'll also build familiarity with the main methodologies of modern economic research: theoretical modeling, empirical analysis of observational data, and experiments.

**Class Format:** Class sessions will largely consist of presentations and discussions of academic research papers, as well as lab sessions to work on empirical exercises and other interactive activities

**Requirements/Evaluation:** class participation, regular reading markup, empirical exercises, oral presentation(s), and an original research paper using an experiment, observational data, or theory

**Prerequisites:** ECON 251 and (ECON 255 or STAT 346)

**Enrollment Limit:** 19

**Enrollment Preferences:** senior Economics majors and junior Economics majors considering a thesis

**Expected Class Size:** 19

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

CAOS 477(D2) ENVI 376(D2) ECON 477(D2)

**Quantitative/Formal Reasoning Notes:** The research students will consume and produce in the class will be based on math-based theory and/or econometric-based empirical analysis.

**Attributes:** CAOS Senior Seminars ENVI Humanities, Arts + Social Science Electives POEC Depth POEC Skills

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**GEOS 234 (S) Introduction to Materials Science** (QFR)

**Cross-listings:** PHYS 234

**Secondary Cross-listing**

Materials Science is the study of how the microscopic structure of materials—whether steel, carbon fiber, glass, wood, plastic, or mayonnaise—determines their macroscopic mechanical, thermal, electric, and other properties. Topics of this course include classifying materials; material structure; thermodynamics and phase transformations; material properties and testing; how solids bend, flow, and ultimately break; and how to choose the right material for design applications. Materials Science is a highly interdisciplinary field and as a result the course prerequisites are broad but also flexible. Interested students who are unsure about their preparation are strongly encouraged to contact the instructor.

**Class Format:** lecture (3 hours per week) plus three to four small-group laboratory sessions throughout the semester (to be scheduled with instructor)

**Requirements/Evaluation:** weekly problem sets, class participation, and midterm and final exams, all of which have a substantial quantitative component

**Prerequisites:** high school physics and chemistry, preferably at the AP level, and MATH 140 or AP Calculus (BC), and one 200-level PHYS, CHEM, or GEOS course; or permission of instructor

**Enrollment Limit:** 20

**Enrollment Preferences:** based on students' scientific background and seniority

**Expected Class Size:** 10

**Grading:** yes pass/fail option, yes fifth course option

**Unit Notes:** This course does not count toward the Geosciences major.

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

PHYS 234(D3) GEOS 234(D3)
Can people live safely along the coast? Recent events like SuperStorm Sandy and the Tohoku Tsunami have shown us how the ocean can rise up suddenly and wreak havoc on our lives and coastal infrastructure. Only educated geoscientists can evaluate the risks and define informed strategies to prevent future coastal catastrophes. Currently almost half the global population lives within 100 km of the coast, with a large percent of those living in densely populated cities (e.g., New York, New Orleans, Los Angeles, Shanghai, Hong Kong, Cape Town, Sydney, Mumbai). Despite the growing risks and challenges associated with climate change and rising sea levels, the coastal population continues to grow rapidly. To help ensure these growing populations can live safely along the coast requires a detailed understanding of the processes that shape the coastal zone. These processes act across a variety of scales, from deep-time geologic processes that dictate coastal shape and structure, to decadal-scale processes that determine shoreline position and evolution, to weekly and daily processes such as storms and tides. This course will provide an in-depth look at the forces--wind, waves, storms, and people--that shape the coastal zone, as well as the geologic formations--sandy beaches, rocky cliffs, barrier islands, deltas, and coral reefs--that are acted upon and resist these forces. Coastal dynamics are strongly affected by human interventions, such as seawalls, dredged channels, and sand dune removal, as well as by sea level rise and changes in storm frequency and magnitude associated with climate change. Finally, the course will provide students with a perspective on how the U.S. seeks to manage its coastal zone, focusing on sea level rise and coastal development. This class will include a quantitative lab that will use MATLAB software to model and evaluate various coastal processes. Students will gain a basic understanding of MATLAB functionality, and will be asked to independently apply what they have learned to various data sets provided by the instructor.

Class Format: lecture two times a week with a lab one time per week
Requirements/Evaluation: lab reports, quizzes, and an independent research project
Prerequisites: Either GEOS 104 or GEOS 210; or permission of instructor. No prior knowledge is necessary, but this course does build on principles used to explore complex scientific challenges.
Enrollment Limit: 15
Enrollment Preferences: Geosciences majors
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: This course counts toward the GEOS Group B Electives - Sediments + Life.
Distributions: (D3) (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 327(D3) GEOS 327(D3) CAOS 327(D3)
Quantitative/Formal Reasoning Notes: This course will involve the use of MATLAB software to quantitatively analyze coastal process and geomorphological data.
Attributes: ENVI Natural World Electives GEOS Group B Electives - Sediments + Life
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

Class Format: This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18
Enrollment Preferences: Students without prior college-level courses in statistics and programming.
Expected Class Size: 18
Grading: no pass/fail option, no fifth course option
Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGTBQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz
LEC Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz

INTR 350 (S) Data for Justice Research Practicum (DPE) (QFR)

Cross-listings: WGSS 363 / STS 363 / AMST 363

Primary Cross-listing
Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10
Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor’s preregistration survey (contact the instructor for link).
Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

Difference, Power, and Equity Notes: Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

Quantitative/Formal Reasoning Notes: Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz
SEM Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz

MATH 113 (S) The Beauty of Numbers (QFR)

This course will be an introduction to number theory and mathematical thinking and logic, with emphasis throughout on mathematics as a way of thinking and approaching the world. Have you ever wondered what keeps your credit card information safe every time you buy something online? Number theory! Number Theory is one of the oldest branches of mathematics. In this course, we will discover the beauty and usefulness of numbers, from ancient Greece to modern cryptography. We will look for patterns, make conjectures, and learn how to prove these conjectures. Starting with nothing more than basic high school algebra, we will develop the logic and critical thinking skills required to realize and prove mathematical results. Topics to be covered include the meaning and content of proof, prime numbers, divisibility, rationality, modular arithmetic, Fermat's Last Theorem, the Golden ratio, Fibonacci numbers, coding theory, and unique factorization. This course is meant to give you an appreciation for numbers and mathematics and to enhance your logical reasoning skills. Although most people will not use calculus or geometry in their jobs or everyday lives, mathematics enhances our abilities to think logically and reason effectively. This skill is useful in all aspects of life. Number theory, in particular, is a great area of mathematics that allows one to jump in right away without a lot of pre-requisite knowledge. We will look at examples, look for patterns, make conjectures, and we will spend a lot of time learning how to rigorously prove those conjectures.

Requirements/Evaluation: projects, homework assignments, and exams

Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test) or permission of instructor. Anyone who has previously taken a 200-level math course or higher must obtain instructor permission to take the course.

Enrollment Limit: 25

Enrollment Preferences: If over-enrolled, course selection will be based on answers to a questionnaire.

Expected Class Size: 25

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: proof writing and logic

Spring 2025

LEC Section: 01 TR 11:20 am - 12:35 pm Allison Pacelli

MATH 130 (F)(S) Calculus I (QFR)

Calculus permits the computation of velocities and other instantaneous rates of change by a limiting process called differentiation. The same process also solves "max-min" problems: how to maximize profit or minimize pollution. A second limiting process, called integration, permits the computation of areas and accumulations of income or medicines. The Fundamental Theorem of Calculus provides a useful and surprising link between the two processes. Subtopics include trigonometry, exponential growth, and logarithms.

Requirements/Evaluation: Weekly homework and quizzes, 2 exams during the semester, and one final

Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test); this is an introductory course for students who have not seen calculus before
Enrollment Limit: 50
Enrollment Preferences: first-year students

Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option

Unit Notes: students who have previously taken a calculus course may not enroll in MATH 130 without the permission of instructor

Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This a calculus course.

Fall 2024
LEC Section: 02  MWF 9:00 am - 9:50 am  Lori A. Pedersen
LEC Section: 01  MWF 8:00 am - 8:50 am  Lori A. Pedersen

Spring 2025
LEC Section: 01  MWF 9:00 am - 9:50 am  Leo Goldmakher

MATH 140 (F)(S) Calculus II (QFR)

Calculus answers two basic questions: how fast is something changing (the derivative) and how much is there (the integral). This course is about integration, and the miracle that unites the derivative and the integral (the Fundamental Theorem of Calculus.) Understanding calculus requires in part the understanding of methods of integration. This course will also solve equations involving derivatives (“differential equations”) for population growth or pollution levels. Exponential and logarithmic functions and trigonometric and inverse functions will also play an important role. This course is the right starting point for students who have seen derivatives, but not necessarily integrals, before.

Requirements/Evaluation: homework, quizzes, and/or exams
Prerequisites: MATH 130 or equivalent; students who have received the equivalent of advanced placement of AB 4, BC 3 or higher may not enroll in MATH 140 without the permission of instructor

Enrollment Limit: 50
Enrollment Preferences: based on who needs calculus the soonest

Expected Class Size: 30
Grading: yes pass/fail option, yes fifth course option

Unit Notes: students who have higher advanced placement must enroll in MATH 150 or above
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is a math class

Fall 2024
LEC Section: 01  MWF 9:00 am - 9:50 am  Bhagya Athukorallage
LEC Section: 02  MWF 12:00 pm - 12:50 pm  Bhagya Athukorallage

Spring 2025
LEC Section: 01  MWF 10:00 am - 10:50 am  Christina Athanasouli

MATH 150 (F)(S) Multivariable Calculus (QFR)

Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives, multiple integrals. There is also a unit on infinite series, sometimes with applications to differential equations.

Requirements/Evaluation: Problem sets and exams
Prerequisites: MATH 140 or equivalent, such as satisfactory performance on an Advanced Placement Examination

Enrollment Limit: 50
Enrollment Preferences: Preference will be given to prospective math and stats majors, or students who need this as a course to serve as a
MATH 150  (F)  Multivariable Calculus  (QFR)
Applications of calculus in mathematics, science, economics, psychology, the social sciences, involve several variables. This course extends calculus to several variables: vectors, partial derivatives, multiple integrals. The goal of the course is Stokes Theorem, a deep and profound generalization of the Fundamental Theorem of Calculus. The difference between this course and MATH 150 is that MATH 150 covers infinite series instead of the theorems of vector calculus. Students with the equivalent of BC 3 or higher should enroll in MATH 151, as well as students who have taken the equivalent of an integral calculus and who have already been exposed to infinite series. For further clarification as to whether MATH 150 or MATH 151 is appropriate, please consult a member of the math/stat department.

Requirements/Evaluation: problem sets and exams
Prerequisites: AP BC 3 or higher or integral calculus with infinite series
Enrollment Limit: 50
Enrollment Preferences: First-years, sophomores, and juniors
Expected Class Size: 40
Grading: yes pass/fail option, yes fifth course option
Unit Notes: MATH 151 satisfies any MATH 150 prerequisite; credit will not be given for both MATH 150 and MATH 151
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course builds quantitative skills

MATH 200  (F)(S)  Discrete Mathematics  (QFR)
In contrast to calculus, which is the study of continuous processes, this course examines the structure and properties of finite sets. Topics to be covered include mathematical logic, elementary number theory, mathematical induction, set theory, functions, relations, elementary combinatorics, and probability, and graphs. Emphasis will be given on the methods and styles of mathematical proofs, in order to prepare the students for more advanced math courses.

Class Format: This will not be a typical lecture course; instead it will be a blend of lecture and discovery-based learning, with weekly small group meetings with TA's.

Requirements/Evaluation: Spring: Evaluation will be based on homework, exams, and participation in weekly small group meetings.
Prerequisites: Calculus at the level of an AP course or Williams College Math 130 or 140. Students who have taken a 300-level or 400-level math
course should obtain permission of the instructor before enrolling.

**Enrollment Limit:** 40

**Enrollment Preferences:** Preference given to first and second year students intending to major in mathematics or computer science.

**Expected Class Size:** 40

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course involves developing the formal mathematical language of logic and set theory. It also involves using quantitative tools to solve problems relating to combinatorics, probability, number theory, and other fields of discrete mathematics.

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**Fall 2024**

LEC Section: 02    TR 11:20 am - 12:35 pm    Palak Arora
LEC Section: 01    TR 9:55 am - 11:10 am    Palak Arora

**Spring 2025**

LEC Section: 02    TR 9:55 am - 11:10 am    Lori A. Pedersen
LEC Section: 01    TR 8:30 am - 9:45 am    Lori A. Pedersen

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**MATH 210 (S) Mathematical Methods for Scientists (QFR)**

**Cross-listings:** PHYS 210

**Secondary Cross-listing**

This course covers a variety of mathematical methods used in the sciences, focusing particularly on the solution of ordinary and partial differential equations. In addition to calling attention to certain special equations that arise frequently in the study of waves and diffusion, we develop general techniques such as looking for series solutions and, in the case of nonlinear equations, using phase portraits and linearizing around fixed points. We study some simple numerical techniques for solving differential equations. An optional session in Mathematica will be offered for students who are not already familiar with this computational tool.

**Class Format:** three hours per week

**Requirements/Evaluation:** several exams and weekly problem sets, all of which have a substantial quantitative component

**Prerequisites:** MATH 150 or 151 and familiarity with Newtonian mechanics at the level of PHYS 131

**Enrollment Limit:** 50

**Enrollment Preferences:** sophomores and juniors

**Expected Class Size:** 30

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**

PHYS 210(D3) MATH 210(D3)

**Quantitative/Formal Reasoning Notes:** This course will have weekly problem sets using advanced calculus methods

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**Spring 2025**

LEC Section: 01    TR 9:55 am - 11:10 am    Frederick W. Strauch

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**MATH 250 (F)(S) Linear Algebra (QFR)**

Many social, political, economic, biological, and physical phenomena can be described, at least approximately, by linear relations. In the study of systems of linear equations one may ask: When does a solution exist? When is it unique? How does one find it? How can one interpret it geometrically? This course develops the theoretical structure underlying answers to these and other questions and includes the study of matrices, vector spaces, linear independence and bases, linear transformations, determinants and inner products. Course work is balanced between theoretical and computational, with attention to improving mathematical style and sophistication.

**Requirements/Evaluation:** homework and exams
Prerequisites: MATH 150/151 or MATH 200

Enrollment Limit: 60

Enrollment Preferences: Students who have officially declared a major that requires Math 250.

Expected Class Size: 40

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: In this course, students will engage in both quantitative and formal reasoning.

Attributes: COGS Related Courses

Fall 2024
LEC Section: 01 MWF 10:00 am - 10:50 am Christina Athanasouli
LEC Section: 02 MWF 11:00 am - 11:50 am Christina Athanasouli

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Ivo Terek
LEC Section: 02 MWF 10:00 am - 10:50 am Ivo Terek

MATH 309 (F)(S) Differential Equations (QFR)
Ordinary differential equations (ODEs) frequently arise as models of phenomena in the natural and social sciences. This course presents core ideas of ODEs from an applied standpoint. Topics covered early in the course may include numerical solutions, separation of variables, integrating factors, and constant coefficient linear equations. Later, we will focus on nonlinear ODEs, for which it is usually impossible to find analytical solutions. Tools from dynamical systems will be introduced to allow us to obtain information about the behavior of the ODEs without explicitly knowing the solution.

Requirements/Evaluation: quizzes/exams, problem sets, participation

Prerequisites: MATH 150/151 and MATH 250

Enrollment Limit: 40

Enrollment Preferences: discretion of the instructor

Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: 300-level mathematics course

Fall 2024
LEC Section: 01 TR 9:55 am - 11:10 am Julie C. Blackwood

Spring 2025
LEC Section: 01 TR 8:30 am - 9:45 am Bhagya Athukorallage

MATH 313 (S) Introduction to Number Theory (WS) (QFR)
The study of numbers dates back thousands of years, and is fundamental in mathematics. In this course, we will investigate both classical and modern questions about numbers. In particular, we will explore the integers, and examine issues involving primes, divisibility, and congruences. We will also look at the ideas of number and prime in more general settings, and consider fascinating questions that are simple to understand, but can be quite difficult to answer. This course will include a significant focus on mathematical proof writing and problem solving skills. This includes writing clear and rigorous mathematical proofs, clearly explaining mathematical ideas verbally and in writing, determining how to approach certain types of problems, looking for patterns and making conjectures, and asking good questions about the implications of certain ideas and theorems.

Requirements/Evaluation: Problem sets, project, and exams

Prerequisites: MATH 250 or permission of instructor

Enrollment Limit: 19
Enrollment Preferences: If course is over-enrolled, enrollment preference will be based on answers to a questionnaire. Some preference will be given to students who have not yet had Math 355.

Expected Class Size: 19

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (WS) (QFR)

Writing Skills Notes: Students will complete weekly problem sets, with a strong emphasis on proof writing, as well as 2 5-10 page papers/projects. There will be feedback given on mathematical writing as well as accuracy, and discussion time during class on writing in math.

Quantitative/Formal Reasoning Notes: This course requires working with various number systems, performing explicit computations, and proving mathematical results using logical reasoning practices.

Spring 2025
LEC Section: 01 TR 9:55 am - 11:10 am Allison Pacelli

MATH 326 (F) Differential Geometry (QFR)
Differential Geometry is the study of curvature. In turn, curvature is the heart of geometry. The goal of this course is to start the study of curvature, concentrating on the curvature of curves and of surfaces, leading to the deep Gauss-Bonnet Theorem, which links curvature with topology.

Class Format: lecture

Requirements/Evaluation: Evaluation will be based primarily on problem sets, midterms and a final exam

Prerequisites: MATH 250

Enrollment Limit: 30

Enrollment Preferences: Preference to mathematics majors.

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is a mathematics upper level course.

Fall 2024
LEC Section: 01 MWF 11:00 am - 11:50 am Ivo Terek

MATH 331 (F) The little Questions (QFR)
Using math competitions such as the Putnam Exam as a springboard, in this class we follow the dictum of the Ross Program and "think deeply of simple things". The two main goals of this course are to prepare students for competitive math competitions, and to get a sense of the mathematical landscape encompassing elementary number theory, combinatorics, graph theory, and group theory (among others). While elementary frequently is not synonymous with easy, we will see many beautiful proofs and "a-ha" moments in the course of our investigations. Students will be encouraged to explore these topics at levels compatible with their backgrounds.

Requirements/Evaluation: homework, classwork, and exams

Prerequisites: MATH 250 or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: members or alternates of the Putnam team, Mathematics, Physics or Computer Science majors

Expected Class Size: 25

Grading: yes pass/fail option, yes fifth course option

Unit Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/331Fa24/

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an upper level math course where students learn advanced material and solve challenging problems.
MATH 334 (S) Graph Theory (QFR)
A graph is a collection of vertices, joined together by edges. In this course, we will study the sorts of structures that can be encoded in graphs, along with the properties of those graphs. We'll learn about such classes of graphs as multi-partite, planar, and perfect graphs, and will see applications to such optimization problems as minimum colorings of graphs, maximum matchings in graphs, and network flows.

Requirements/Evaluation: problem sets, exams, and a short final project
Prerequisites: MATH 200 or MATH 250
Enrollment Limit: 30
Enrollment Preferences: Math majors
Expected Class Size: 25
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course involves the writing of mathematical proofs.

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Ralph E. Morrison

MATH 338 (F) Intermediate Logic (QFR)
Cross listings: PHIL 338
Secondary Cross-listing
In this course, we will begin with an in-depth study of the theory of first-order logic. We will first get clear on the formal semantics of first-order logic and various ways of thinking about formal proof: natural deduction systems, semantic tableaux, axiomatic systems and sequent calculi. Our main goal will be to prove things about this logical system rather than to use this system to think about ordinary language arguments. In this way the goal of the course is significantly different from that of Logic and Language (PHIL 203). Students who have take PHIL 203 will have a good background for this class, but students who are generally comfortable with formal systems need not have taken PHIL 203. We will prove soundness and completeness, compactness, the Lowenheim-Skolem theorems, undecidability and other important results about first-order logic. As we go through these results, we will think about the philosophical implications of first-order logic. From there, we will look at extensions of and/or alternatives to first-order logic. Possible additional topics would include: modal logic, the theory of counterfactuals, alternative representations of conditionals, the use of logic in the foundations of arithmetic and Godel's Incompleteness theorems. Student interest will be taken into consideration in deciding what additional topics to cover.

Requirements/Evaluation: problem sets and exams
Prerequisites: some class in which student has studied formal reasoning
Enrollment Limit: 20
Enrollment Preferences: Philosophy majors; juniors and seniors
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHIL 338(D2) MATH 338(D3)

Quantitative/Formal Reasoning Notes: This is a class in Formal Logic. PHIL 203 satisfies the QFR requirement. If anything, this class will be significantly more formal.
Attributes: PHIL Contemp Metaphysics + Epistemology Courses

Fall 2024
MATH 341  (F)(S) Probability  (QFR)
Cross-listings: STAT 341
Primary Cross-listing
The historical roots of probability lie in the study of games of chance. Modern probability, however, is a mathematical discipline that has wide applications in a myriad of other mathematical and physical sciences. Drawing on classical gaming examples for motivation, this course will present axiomatic and mathematical aspects of probability. Included will be discussions of random variables (both discrete and continuous), distribution and expectation, independence, laws of large numbers, and the well-known Central Limit Theorem. Many interesting and important applications will also be presented, including some from classical Poisson processes, random walks and Markov Chains.
Requirements/Evaluation: homework, classwork, and exams
Prerequisites: MATH 150 and MATH 250 or permission of the instructor
Enrollment Limit: 50
Enrollment Preferences: Priority will be given to Mathematics majors and to Statistics Majors.
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3)  (QFR)
This course is cross-listed and the prefixes carry the following divisional credit:
STAT 341(D3) MATH 341(D3)
Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2024
LEC Section: 01  MWF 12:00 pm - 12:50 pm  Mihai Stoiciu

Spring 2025
LEC Section: 01  TR 9:55 am - 11:10 am  Steven J. Miller

MATH 345  (S) Introduction to Numerical Analysis  (QFR)
Numerical analysis is the study of algorithms that use numerical approximation to solve problems which arise in scientific applications. This course provides an introduction to the theory, development, and analysis of algorithms for obtaining numerical solutions. We will also use mathematical software to facilitate numerical experimentation. Topics discussed in the course include: Error Analysis and Convergence Rates of Algorithms; Root Finding for Nonlinear Equations; Approximating Functions; Numerical Differentiation and Integration; Numerical Solutions of Ordinary Differential Equations; Iterative Methods for Solving Linear Systems.
Requirements/Evaluation: Evaluation will be based on homework, projects, and exams.
Prerequisites: Math 250 and Math 150/151
Enrollment Limit: 30
Enrollment Preferences: Mathematics and Statistics majors.
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This is an advanced mathematics class that will cover the fundamental ideas of Numerical Analysis. The students will study in depths various algorithms that provide numerical solutions to various questions in science.

Spring 2025
LEC Section: 01  MWF 11:00 am - 11:50 am  Christina Athanasouli

MATH 350  (F)(S) Real Analysis  (QFR)
Why is the product of two negative numbers positive? Why do we depict the real numbers as a line? Why is this line continuous, and what do we mean when we say that? Perhaps most fundamentally, what is a real number? Real analysis addresses such questions, delving into the structure of real numbers and functions of them. Along the way we'll discuss sequences and limits, series, completeness, compactness, derivatives and integrals, and metric spaces. Results covered will include the Cantor-Schroeder-Bernstein theorem, the monotone convergence theorem, the Bolzano-Weierstrass theorem, the Cauchy criterion, Dirichlet's and Riemann's rearrangement theorem, the Heine-Borel theorem, the intermediate value theorem, and many others. This course is excellent preparation for graduate studies in mathematics, statistics, and economics.

**Requirements/Evaluation:** Problem sets and exams.

**Prerequisites:** MATH 250 or permission of instructor.

**Enrollment Limit:** 40

**Enrollment Preferences:** Juniors and Seniors.

**Expected Class Size:** 25

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This is an advanced mathematics course.

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**Fall 2024**

LEC Section: 01  MR 2:35 pm - 3:50 pm  Leo Goldmakher

**Spring 2025**

LEC Section: 01  TR 11:20 am - 12:35 pm  Cesar E. Silva

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**MATH 351 (S) Applied Real Analysis (QFR)**

This course is designed to introduce students to the underpinnings of real analysis, primarily in the context of Fourier series. By the end of the semester people will be comfortable making epsilon and delta type arguments. These types of arguments are one of the main pillars of modern mathematics. In a similar way, Fourier series and their generalizations are one of the pillars of the modern digital world.

**Requirements/Evaluation:** homework, classwork, and exams

**Prerequisites:** MATH 150 and MATH 250 or permission of the instructor.

**Enrollment Limit:** 50

**Enrollment Preferences:** Seniors

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** Math

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**Spring 2025**

LEC Section: 01  MR 2:35 pm - 3:50 pm  Palak Arora

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**MATH 355 (F)(S) Abstract Algebra (QFR)**

Algebra gives us tools to solve equations. The integers, the rationals, and the real numbers have special properties which make algebra work according to the circumstances. In this course, we generalize algebraic processes and the sets upon which they operate in order to better understand, theoretically, when equations can and cannot be solved. We define and study abstract algebraic structures such as groups, rings, and fields, as well as the concepts of factor group, quotient ring, homomorphism, isomorphism, and various types of field extensions. This course introduces students to abstract rigorous mathematics.

**Requirements/Evaluation:** Problem sets and exams

**Prerequisites:** MATH 250 or permission of instructor

**Enrollment Limit:** 30
**Enrollment Preferences:** Students who have officially declared a major that requires Math 355.

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** 300-level math course

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**Fall 2024**

LEC Section: 02  TR 9:55 am - 11:10 am  Allison Pacelli

LEC Section: 01  TR 8:30 am - 9:45 am  Allison Pacelli

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**Spring 2025**

LEC Section: 01  MWF 11:00 am - 11:50 am  Mihai Stoiciu

LEC Section: 02  MWF 12:00 pm - 12:50 pm  Mihai Stoiciu

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**MATH 361 (F) Theory of Computation** (QFR)

**Cross-listings:** CSCI 361

**Secondary Cross-listing**

This course introduces a formal framework for investigating both the computability and complexity of problems. We study several models of computation including finite automata, regular languages, context-free grammars, and Turing machines. These models provide a mathematical basis for the study of computability theory—the examination of what problems can be solved and what problems cannot be solved—and the study of complexity theory—the examination of how efficiently problems can be solved. Topics include the halting problem and the P versus NP problem.

**Requirements/Evaluation:** weekly problem sets and one or more exams

**Prerequisites:** CSCI 256 or both a 300-level MATH course and permission of instructor

**Enrollment Limit:** 24

**Enrollment Preferences:** current or expected Computer Science majors

**Expected Class Size:** 24

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**

MATH 361(D3) CSCI 361(D3)

**Quantitative/Formal Reasoning Notes:** This course include regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

**Attributes:** COGS Interdepartmental Electives

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**Fall 2024**

LEC Section: 02  TR 9:55 am - 11:10 am  Shikha Singh

LEC Section: 01  TR 8:30 am - 9:45 am  Shikha Singh

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**MATH 374 (F) Topology** (QFR)

In Real Analysis you learned about metric spaces—any set of objects endowed with a way of measuring distance—and the topology of sets in such spaces (open, closed, bounded, etc). In this course we flip this on its head: we explore how to develop analysis (limits, continuity, etc) in spaces where the topology is known but the metric is not. This will lead us to a bizarre and fascinating version of geometry in which we cannot distinguish between shapes that can be continuously deformed into one another. Not only does this theory turn out to be beautiful in the abstract, it plays an important role in math, physics, and data analysis. This course is excellent preparation for graduate programs in mathematics.

**Requirements/Evaluation:** Problem sets, exams, an expository essay.

**Prerequisites:** MATH 350 or 351; not open to students who have taken MATH 323. If you didn't cover metric spaces in real analysis, that's OK!
Enrollment Limit: 30
Enrollment Preferences: Juniors and seniors
Expected Class Size: 20
Grading: no pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: It's math.

Fall 2024
LEC Section: 01 TR 11:20 am - 12:35 pm Leo Goldmakher
MATH 382 (S) Fourier Analysis (QFR)
Fourier analysis is the study of waves and frequencies. More precisely, the goal of Fourier analysis is to decompose a complicated function into a simple combination of pure waves, thereby gleaning insight into the behavior of the function itself. It's difficult to overstate the impact of this branch of mathematics; it is foundational throughout theoretical mathematics (e.g., to study the distribution of prime numbers), applied mathematics (e.g., to solve differential equations), physics (e.g., to study properties of light and sound), computer science (e.g., to compute with large integers and matrices), audio engineering (e.g., to pitch-correcting algorithms), medical science (e.g., throughout radiology), etc. The goal of this course is to cover the basic theory (fourier series, the fourier transform, the fast fourier transform) and explore a number of applications, including Dirichlet's theorem on primes in arithmetic progressions, the isoperimetric inequality, the heat equation, and Heisenberg's uncertainty principle.

Class Format: Every week, each student will either give a lecture (based on provided readings) or explain solutions to selected problems.
Requirements/Evaluation: Evaluation will be based on lectures and presentation of problem solutions.
Prerequisites: MATH 350 or MATH 351 or permission of instructor.
Enrollment Limit: 10
Enrollment Preferences: By lottery.
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: It's math!

Spring 2025
TUT Section: T1 TBA Leo Goldmakher
MATH 389 (S) Advanced Analysis (WS) (QFR)
This course further develops and explores topics and concepts from real analysis, with special emphasis on introducing students to subject matter and techniques that are useful for graduate study in mathematics or an allied field. Material will be drawn, based on student interest, from many areas, including analytic number theory, Fourier series and harmonic analysis, generating functions, differential equations and special functions, integral operators, equidistribution theory and probability, random matrix theory and probabilistic methods. This will be an intense, fast paced class which will give a flavor for graduate school. In addition to standard homework problems, students will also write reviews for MathSciNet, referee papers for journals, write programs in SAGE or Mathematica to investigate and conjecture, and read classic and current research papers.

Class Format: lecture
Requirements/Evaluation: evaluation will be based primarily on homework, classwork, and exams
Prerequisites: MATH 350 or 351 and one additional 300-level MATH course, or permission of instructor
Enrollment Limit: 30
Enrollment Preferences: students interested in graduate school in mathematics or an allied discipline
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Unit Notes: http://web.williams.edu/Mathematics/sjmiller/public_html/389/
Distributions: (D3) (WS) (QFR)

Writing Skills Notes: Students will improve and expand their writing skills by taking course material as a starting point and writing chapters for a book under contract with the American Mathematical Society. This will involve numerous iterations of the content, with feedback both from the professor and from an editor.

Quantitative/Formal Reasoning Notes: This is a post-core 300 level math class.

Spring 2025
LEC Section: 01    TR 11:20 am - 12:35 pm    Steven J. Miller

MATH 403  (F)  Measure and Ergodic Theory  (QFR)
An introduction to measure theory and ergodic theory. Measure theory is a generalization of the notion of length and area, and has been used in the study of stochastic (probabilistic) systems. The course covers the construction of Lebesgue and Borel measures, measurable functions, and Lebesgue integration. Ergodic theory studies the probabilistic behavior of dynamical systems as they evolve through time, and is based on measure theory. The course will cover basic notions, such as ergodic transformations, weak mixing, mixing, Bernoulli transformations, and transformations admitting and not admitting an invariant measure. There will be an emphasis on specific examples such as group rotations, the binary odometer transformations, and rank-one constructions. The Ergodic Theorem will also be covered, and will be used to illustrate notions and theorems from measure theory.

Requirements/Evaluation: Homework and exams
Prerequisites: MATH 350 or MATH 351 or permission of instructor
Enrollment Limit: 25
Enrollment Preferences: Mathematics majors
Expected Class Size: 15-20
Grading: yes pass/fail option, yes fifth course option

Fall 2024
LEC Section: 01    MR 2:35 pm - 3:50 pm    Cesar E. Silva

MATH 408  (F)  L-Functions and Sphere Packing  (WS) (QFR)
Optimal packing problems arise in many important problems, and have been a source of excellent mathematics for centuries. The Kepler Problem (what is the most efficient way to pack balls in three-space) is a good example. The original formulation has been used in such diverse areas as stacking cannonballs on battleships to grocers preparing fruit displays, and its generalizations allow the creation of powerful error detection and correction codes. While the solution of the Kepler Problem is now known, the higher dimensional version is very much open. There has been remarkable progress in the last few years, with number theory playing a key role in these results. We will develop sufficient background material to understand many of these problems and the current state of the field. Pre-requisites are real analysis.

Requirements/Evaluation: Class participation, homework, exams and participation in writing a textbook on the material. Each student will be responsible for working on a chapter of a book based on this material. In addition to obtaining critical writing feedback from myself and my co-author (who is a world expert in the subject), depending on timing we will also be able to share comments from an editor of a major publishing house or a referee. Chapters can range from short snapshots of a subject, on the order of 5 pages, to longer technical derivations of perhaps 10-30 pages.
Prerequisites: Math 350 or 351
Enrollment Limit: 40
Enrollment Preferences: Senior math majors, students planning on graduate study in a STEM field
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (WS) (QFR)
Writing Skills Notes: Students will improve and expand their writing skills by taking course material as a starting point and writing chapters for a book.
under contract with the American Mathematical Society. This will involve numerous iterations of the content, with feedback both from the professor and from an editor.

**Quantitative/Formal Reasoning Notes:** This is a 400 level math class

### Fall 2024

**LEC Section: 01**  
MWF 11:00 am - 11:50 am  
Steven J. Miller

**MATH 411 (S) Commutative Algebra (QFR)**

C Commutative Algebra is an essential area of mathematics that provides indispensable tools to many areas, including Number Theory and Algebraic Geometry. This course will introduce you to the fundamental concepts for the study of commutative rings, with a special focus on the notion of "prime ideals," and how they generalize the well-known notion of primality in the set of integers. Commutative algebra has applications ranging from algebraic geometry to coding theory. For example, one can use commutative algebra to create error correcting codes. It is perhaps most often used, however, to study curves and surfaces in different spaces. To understand these structures, one must study polynomial rings over fields. This course will be an introduction to commutative algebra. Possible topics include polynomial rings, localizations, primary decomposition, completions, and modules.

**Requirements/Evaluation:** homework and exams

**Prerequisites:** MATH 355 or permission of instructor

**Enrollment Limit:** 25

**Enrollment Preferences:** Math majors

**Expected Class Size:** 15

**Grading:**  
yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** It is a 400-level math course

### Spring 2025

**LEC Section: 01**  
MWF 9:00 am - 9:50 am  
Susan R. Loepp

**MATH 412 (S) Mathematical Biology (QFR)**

**Cross-listings:** BIOL 420

**Primary Cross-listing**

This course will provide an introduction to the many ways in which mathematics can be used to understand, analyze, and predict biological dynamics. We will learn how to construct mathematical models that capture essential properties of biological processes while maintaining analytic tractability. Analytic techniques, such as stability and bifurcation analysis, will be introduced in the context of both continuous and discrete time models. Additionally, students will couple these analytic tools with numerical simulation to gain a more global picture of the biological dynamics. Possible biological applications may include, but are not limited to, single and multi-species population dynamics, neural and biological oscillators, tumor cell growth, and infectious disease dynamics.

**Requirements/Evaluation:**  
problem sets, quizzes/exams, participation, final project and paper

**Prerequisites:** MATH 250 and MATH 309, or permission of instructor

**Enrollment Limit:** 30

**Enrollment Preferences:** preference for senior math/stats major and also based on an interest statement

**Expected Class Size:** 30

**Grading:**  
yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**This course is cross-listed and the prefixes carry the following divisional credit:**

MATH 412(D3) BIOL 420(D3)

**Quantitative/Formal Reasoning Notes:** The course will introduce methods for developing and analyzing mathematical models.
MATH 426 (F) Differential Topology (QFR)
Differential topology marries the rubber-like deformations of topology with the computational exactness of calculus. This subfield of mathematics asks and answers questions like "Can you take an integral on the surface of a doughnut?" and includes far-reaching applications in relativity and robotics. This tutorial will provide an elementary and intuitive introduction to differential topology. We will begin with the definition of a manifold and end with a generalized understanding of Stokes Theorem.

Requirements/Evaluation: weekly homework and exams, and possibly student presentations
Prerequisites: MATH 350 (students who have not taken MATH 350 may enroll only with permission of the instructor)
Enrollment Limit: 30
Enrollment Preferences: mathematics seniors, mathematics majors
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: There will be weekly math problem sets.

MATH 453 (S) Partial Differential Equations (QFR)
In this course, we further explore the world of differential equations. Mainly, we cover topics in partial differential equations. Partial Differential Equations (PDEs) are fundamental to the modeling of many natural phenomena, arising in many fields, including fluid mechanics, heat and mass transfer, electromagnetic theory, finance, elasticity, and more. The goals of this course are to discuss the following topics: classification of PDEs in terms of order, linearity and homogeneity; physical interpretation of canonical PDEs; solution techniques, including separation of variables, series solutions, integral transforms, and the method of characteristics.

Requirements/Evaluation: Evaluation will be based on homework, projects, and exams.
Prerequisites: MATH 150-151; MATH/PHYS 210 or MATH 309
Enrollment Limit: 20
Enrollment Preferences: Mathematics and Physics majors.
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This is an advanced mathematics class dedicated to the study of partial differential equations (PDEs). These equations are the most important mathematical tools for the study of complex physical phenomena such as waves and fluids (including both air and water), heat transfer, electromagnetism, and finance.

PHIL 203 (S) Introductory Logic (QFR)
Logic is the study of reasoning and argument. More particularly, it concerns itself with the differences between good and bad reasoning, between strong and weak arguments. This course is an introduction to the precise characterization of good logical reasoning. We will learn a to a formal language, Monadic First-Order Logic, designed to cleanly represent good inference patterns. Learning this language will primarily involve learning two skills: (i) translation between sentences of English and formulas of the logical language, and (ii) proving the validity of logical arguments using a system of natural deduction. No prior mathematical/logical/formal experience is assumed for this course.
**PHIL 221 (F) Introduction to Formal Linguistics** (QFR)

The sentence "Every cookie is chocolate chip and three of them are oatmeal raisin" is a perfectly grammatical sentence of English, but it's self-contradictory. What does it take to realize this fact? One must grasp the meanings of the various parts of the sentence. In particular, one must grasp that "three of them" picks out a subset of the group picked out by "every cookie", and that there's no such thing as a cookie that is both chocolate chip and oatmeal raisin. There two ways to understand "Many students took every class". According to one, there is a single group of students that had their hands extremely full this semester. According to the other, every class was well-populated, potentially by different groups. The reason for this is that there are two underlying structures that the original sentence can realize. This course serves as an introduction to formal methods in the scientific study of language. Our goal will be to characterize phenomena like those above with logical and mathematical precision. The focus will be on model-theoretic semantics, the sub-field of linguistics that studies meanings. Along the way we will discuss principles of syntax, the sub-field that studies sentence structures, and pragmatics, the sub-field that studies inferences of non-literal content. This is a formal course, but no prior logical or mathematical background will be expected. Starting from scratch, students will learn the building blocks of current-day linguistic research. This introduction will be of use to students interested in language from a variety of perspectives, including philosophy, cognitive science, and computer science.

**Requirements/Evaluation:** Weekly problem sets, plus a final project (paper/presentation/other type, to be discussed with instructor)

**Prerequisites:** No prerequisites

**Enrollment Limit:** 20

**Enrollment Preferences:** Preference given to seniors and philosophy/cognitive science majors.

**Expected Class Size:** 20

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D2) (QFR)

**Quantitative/Formal Reasoning Notes:** This course teaches the fundamentals of the formal analysis of language. Students will learn to provide translation schemes from English to a logical language (typed lambda calculus).

**Attributes:** COGS Interdepartmental Electives  COGS Related Courses  Linguistics  PHIL Contemp Metaphysics + Epistemology Courses
In this course, we will begin with an in-depth study of the theory of first-order logic. We will first get clear on the formal semantics of first-order logic and various ways of thinking about formal proof: natural deduction systems, semantic tableaux, axiomatic systems and sequent calculi. Our main goal will be to prove things about this logical system rather than to use this system to think about ordinary language arguments. In this way the goal of the course is significantly different from that of Logic and Language (PHIL 203). Students who have take PHIL 203 will have a good background for this class, but students who are generally comfortable with formal systems need not have taken PHIL 203. We will prove soundness and completeness, compactness, the Lowenheim-Skolem theorems, undecidability and other important results about first-order logic. As we go through these results, we will think about the philosophical implications of first-order logic. From there, we will look at extensions of and/or alternatives to first-order logic. Possible additional topics would include: modal logic, the theory of counterfactuals, alternative representations of conditionals, the use of logic in the foundations of arithmetic and Godel's Incompleteness theorems. Student interest will be taken into consideration in deciding what additional topics to cover.

Requirements/Evaluation: problem sets and exams
Prerequisites: some class in which student has studied formal reasoning
Enrollment Limit: 20
Expected Class Size: 15
Grading: yes pass/fail option, yes fifth course option
Distributions: (D2) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
PHIL 338(D2) MATH 338(D3)

Quantitative/Formal Reasoning Notes: This is a class in Formal Logic. PHIL 203 satisfies the QFR requirement. If anything, this class will be significantly more formal.

Attributes: PHIL Contemp Metaphysics + Epistemology Courses

Fall 2024
SEM Section: 01 TF 2:35 pm - 3:50 pm Keith E. McPartland

PHYS 108 (S) Energy Science and Technology (QFR)

Cross-listings: ENVI 108

Primary Cross-listing

Energy use has skyrocketed in the United States and elsewhere in the world, causing significant economic and political shifts, as well as concerns for the environment. This course will address the physics and technology of energy generation, consumption, and conservation. It will cover a wide range of energy sources, including fossil fuels, hydropower, solar energy, wind energy, and nuclear energy. We will discuss energy use in transportation, manufacturing, building heating and lighting, and energy storage. Students will learn to compare the efficiencies and environmental impacts of various energy sources and uses.

Class Format: Two meetings per week. Some weeks that means two lectures. Other weeks, that means one lecture plus one lab, with the class divided between two lab sections.
Requirements/Evaluation: weekly assignments, two hour tests, and a final project culminating in an oral presentation to the class and a 10-page paper; all of these will be substantially quantitative
Prerequisites: high school physics, high school chemistry, and mathematics at the level of MATH 130
Enrollment Limit: 10 per lab
Expected Class Size: 20
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
ENVI 108(D3) PHYS 108(D3)

ENVI 108(D3) PHYS 108(D3)
Quantitative/Formal Reasoning Notes: problems sets, exams, and projects will all have a quantitative aspects.

Attributes: ENVI Natural World Electives

Spring 2025

LAB Section: 02  R 1:10 pm - 2:25 pm  Protik K. Majumder
LAB Section: 03  R 2:25 pm - 3:50 pm  Protik K. Majumder
LEC Section: 01  MR 1:10 pm - 2:25 pm  Protik K. Majumder

PHYS 131 (F) Introduction to Mechanics (QFR)
We focus first on the Newtonian mechanics of point particles: the relationship between velocity, acceleration, and position; the puzzle of circular motion; forces, Newton's laws, and gravitation; energy and momentum; and the physics of vibrations. Then we turn to the basic properties of waves, such as interference and refraction, as exemplified by sound and light waves. We also study the optics of lenses, mirrors and the human eye. This course is not intended for students who have successfully completed an AP physics course in high school.

Requirements/Evaluation: exams, labs, and weekly problem sets, all of which have a substantial quantitative component
Prerequisites: MATH 130; students who scored 4 or 5 on an AP physics exam, or 6 or 7 on the IB Physics HL exam may not take this course and are encouraged to take PHYS 141 instead
Enrollment Limit: 24 per lab
Enrollment Preferences: seniority
Expected Class Size: 60
Grading: yes pass/fail option, yes fifth course option

Unit Notes: PHYS 131 can lead to either PHYS 132 (for students wanting a one-year survey of physics) or PHYS 142 (for students considering a Physics or Astrophysics major)
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This class will have weekly problem sets requiring substantial quantitative reasoning

Fall 2024

LAB Section: 03  T 1:00 pm - 4:00 pm  Graham K. Giovanetti
LAB Section: 02  M 1:00 pm - 4:00 pm  Graham K. Giovanetti
LEC Section: 01  MWF 11:00 am - 11:50 am  Graham K. Giovanetti

PHYS 132 (S) Electromagnetism and the Physics of Matter (QFR)
This course is intended as the second half of a one-year survey of physics with some emphasis on applications to medicine. In the first part of the semester we will focus on electromagnetic phenomena. We will introduce the concept of electric and magnetic fields and study in detail the way in which electrical circuits and circuit elements work. The deep connection between electric and magnetic phenomena is highlighted with a discussion of Faraday's Law of Induction. Following our introduction to electromagnetism we will discuss some of the most central topics in twentieth-century physics, including Einstein's theory of special relativity and some aspects of quantum theory. We will end with a treatment of nuclear physics, radioactivity, and uses of radiation.

Class Format: lecture three hours per week, laboratory three hours approximately every other week, and conference section 1 hour approximately every other week
Requirements/Evaluation: weekly problem sets, labs, quizzes and exams
Prerequisites: PHYS 131 or 141 or permission of instructor, and MATH 130 (formerly 103)
Enrollment Limit: 22 per lab
Enrollment Preferences: sophomores
Expected Class Size: 60
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: Significant homework, exams, quizzes requiring mathematical and physical reasoning.

Spring 2025

LAB Section: 03   T 1:00 pm - 4:00 pm   Catherine Kealhofer
LEC Section: 01   MWF 11:00 am - 11:50 am   Catherine Kealhofer
LAB Section: 02   M 1:00 pm - 4:00 pm   Catherine Kealhofer

PHYS 141 (F) Mechanics and Waves (QFR)
This is the typical first course for a prospective physics major. It covers most of the same topics as PHYS 131, but with a higher level of mathematical sophistication. It is intended for students with solid backgrounds in the sciences, either from high school or college, who are comfortable with basic calculus.

Class Format: lecture, three hours per week; laboratory, three hours approximately every other week; conference section, 1.5 hours approximately every other week

Requirements/Evaluation: weekly problem sets, labs, two 1-hour exams, and a final exam, all of which have a substantial quantitative component

Prerequisites: High school physics (strongly recommended) and MATH 130 or equivalent placement, or permission of the instructor. High school physics at the AP, IB, or equivalent level is neither required nor expected.

Enrollment Limit: 24 per lab

Enrollment Preferences: first-year students and science majors

Expected Class Size: 40

Grading: yes pass/fail option, yes fifth course option

Unit Notes: PHYS 141 can lead to either PHYS 132 (for students wanting a one-year survey of physics) or PHYS 142 (for students considering a Physics or Astrophysics major)

Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course consists of lectures, problem-solving conferences, lab exercises, problem sets and exams, all of which have a substantial quantitative component.

Fall 2024

LAB Section: 02   M 1:00 pm - 4:00 pm   Betul Pamuk
LAB Section: 03   T 1:00 pm - 4:00 pm   Betul Pamuk
LEC Section: 01   MWF 11:00 am - 11:50 am   Betul Pamuk

PHYS 142 (S) Foundations of Modern Physics (QFR)
Newtonian Mechanics, spectacular as it is in describing planetary motion and a wide range of other phenomena, only hints at the richness of behaviors seen in the universe. Special relativity, which extends physics into the realm of high speeds and high energies, requires we rethink our basic notions of space and time. Quantum mechanics successfully describes atoms, molecules, and solids while at the same time calling into question our expectation of what can be predicted by a physical theory. Statistical physics reveals new behaviors that emerge when many particles are present in a system.

This course will survey ideas from each of these three arenas, and can serve either as a terminal course for those seeking to complete a year of physics or as the basis for future advanced study of these topics.

Class Format: lecture, three hours weekly; laboratory, 2-3 hours most weeks, alternating between 'hands-on' sessions and problem-solving/discussion sessions

Requirements/Evaluation: weekly homework, labs, two hour tests, and a final exam, all of which have a substantial quantitative component

Prerequisites: PHYS 141 and MATH 130, or equivalent; PHYS 131 may substitute for PHYS 141 with the permission of instructor; students may not take both PHYS 142 and PHYS 151

Enrollment Limit: 14/L

Enrollment Preferences: first-year students
PHYS 151  (F) Seminar in Modern Physics  (QFR)

Newtonian Mechanics, spectacular as it is in describing planetary motion and a wide range of other phenomena, only hints at the richness of behaviors seen in the universe. Special relativity has extended physics into the realm of high speeds and high energies and requires us to rethink our basic notions of space and time. Quantum mechanics successfully describes atoms, molecules, and solids while at the same time calling into question our notions of what can be predicted by a physical theory. Statistical physics reveals new behaviors that emerge when many particles are present in a system. This course covers the same core material as PHYS 142 but in a small seminar format for students with strong prior preparation in physics.

Class Format: lecture/discussions plus one 3-hour lab per week

Requirements/Evaluation: class participation, weekly lab assignments, weekly problem sets, exams

Prerequisites: placement by the department (see "advanced placement" section in the description about the department). Students may take either PHYS 142 or PHYS 151 but not both

Enrollment Limit: 18

Enrollment Preferences: first-years

Expected Class Size: 16

Grading: yes pass/fail option, yes fifth course option

Unit Notes: this is a small seminar designed for first-year students who have placed out of PHYS 141

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: all assignments in the course have a substantial quantitative component

Fall 2024

LAB Section: 02  T 1:00 pm - 4:00 pm  Catherine Kealhofer

LEC Section: 01  MWF 11:00 am - 12:15 pm  Catherine Kealhofer

PHYS 201  (F) Electricity and Magnetism  (QFR)

The classical theory of electricity and magnetism is very rich yet it can be written in a remarkably succinct form using Maxwell's equations. This course is an introduction to electricity and magnetism and their mathematical description, connecting electric and magnetic phenomena via the special theory of relativity. Topics include electrostatics, magnetic fields, electromagnetic induction, DC and AC circuits, and the electromagnetic properties of matter. The laboratory component of the course is an introduction to electronics where students will develop skills in building and debugging electrical circuits.

Class Format: lecture, three hours per week; laboratory, three hours per week

Requirements/Evaluation: problem sets, labs/conference section assignments, two midterms, and a final exam, all of which have a substantial quantitative component

Prerequisites: PHYS 142 OR 151; MATH 150 or 151; with a preference for MATH 151

Enrollment Limit: 10 per lab

Enrollment Preferences: prospective physics majors, then by seniority

Expected Class Size: 20
**Grading:** yes pass/fail option, yes fifth course option  
**Distributions:** (D3) (QFR)  

**Quantitative/Formal Reasoning Notes:** This course involves significant problem-solving and mathematical analysis of phenomena using calculus, numerical methods, and other quantitative tools.

### FALL 2024

**LAB Section: 03**  
R 1:00 pm - 4:00 pm  
David R. Tucker-Smith

**LAB Section: 02**  
W 1:00 pm - 4:00 pm  
David R. Tucker-Smith

**LEC Section: 01**  
MWF 10:00 am - 10:50 am  
David R. Tucker-Smith

**PHYS 202 (S) Vibrations, Waves and Optics (QFR)**

Waves and oscillations characterize many different physical systems, including vibrating strings and springs, waves at the beach, or those that we hear as sound or see as light. Quantum mechanics describes particles with wave functions, and gravitational waves distort the very fabric of the universe. Despite these diverse settings, waves exhibit several common characteristics, so understanding of a few simple systems can provide insight into a wide array of phenomena. In this course we begin with the study of oscillations of simple systems with only a few degrees of freedom. We then move on to study transverse and longitudinal waves in continuous media in order to gain a general description of wave behavior. We conclude with a focus on electromagnetic waves and in particular on optical examples of wave phenomena such as interference, diffraction, and lasers. Throughout the course we will introduce and develop mathematical tools which will continue to see use in higher-level physics.

**Class Format:** lecture, three hours per week; laboratory, three hours per week  
**Requirements/Evaluation:** problem sets, labs, midterm examinations, and a final exam, all of which have a substantial quantitative component  
**Prerequisites:** PHYS 201; co-requisite: PHYS/MATH 210 or MATH 309 or permission of instructor  
**Enrollment Limit:** 30  
**Enrollment Preferences:** sophomores  
**Expected Class Size:** 20  
**Grading:** yes pass/fail option, yes fifth course option  
**Distributions:** (D3) (QFR)  

**Quantitative/Formal Reasoning Notes:** Weekly problem sets and laboratories which develop and use quantitative skills.

### SPRING 2025

**LAB Section: 02**  
W 1:00 pm - 4:00 pm  
Frederick W. Strauch

**LAB Section: 03**  
R 1:00 pm - 4:00 pm  
Frederick W. Strauch

**LEC Section: 01**  
MWF 10:00 am - 10:50 am  
Katharine E. Jensen

**PHYS 210 (S) Mathematical Methods for Scientists (QFR)**

**Cross-listings:** MATH 210  
**Primary Cross-listing**

This course covers a variety of mathematical methods used in the sciences, focusing particularly on the solution of ordinary and partial differential equations. In addition to calling attention to certain special equations that arise frequently in the study of waves and diffusion, we develop general techniques such as looking for series solutions and, in the case of nonlinear equations, using phase portraits and linearizing around fixed points. We study some simple numerical techniques for solving differential equations. An optional session in Mathematica will be offered for students who are not already familiar with this computational tool.

**Class Format:** three hours per week  
**Requirements/Evaluation:** several exams and weekly problem sets, all of which have a substantial quantitative component  
**Prerequisites:** MATH 150 or 151 and familiarity with Newtonian mechanics at the level of PHYS 131  
**Enrollment Limit:** 50  
**Enrollment Preferences:** sophomores and juniors
Expected Class Size: 30

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

PHYS 210(D3) MATH 210(D3)

Quantitative/Formal Reasoning Notes: This course will have weekly problem sets using advanced calculus methods.

Spring 2025
LEC Section: 01 TR 9:55 am - 11:10 am Frederick W. Strauch

PHYS 234 (S) Introduction to Materials Science (QFR)

Cross-listings: GEOS 234

Primary Cross-listing

Materials Science is the study of how the microscopic structure of materials—whether steel, carbon fiber, glass, wood, plastic, or mayonnaise—determines their macroscopic mechanical, thermal, electric, and other properties. Topics of this course include classifying materials; material structure; thermodynamics and phase transformations; material properties and testing; how solids bend, flow, and ultimately break; and how to choose the right material for design applications. Materials Science is a highly interdisciplinary field and as a result the course prerequisites are broad but also flexible. Interested students who are unsure about their preparation are strongly encouraged to contact the instructor.

Class Format: lecture (3 hours per week) plus three to four small-group laboratory sessions throughout the semester (to be scheduled with instructor)

Requirements/Evaluation: weekly problem sets, class participation, and midterm and final exams, all of which have a substantial quantitative component

Prerequisites: high school physics and chemistry, preferably at the AP level, and MATH 140 or AP Calculus (BC), and one 200-level PHYS, CHEM, or GEOS course; or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: based on students' scientific background and seniority

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Unit Notes: This course does not count toward the Geosciences major.

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

PHYS 234(D3) GEOS 234(D3)

Quantitative/Formal Reasoning Notes: Weekly problem sets and exams all have a substantial quantitative component.

Attributes: MTSC Courses

Spring 2025
LEC Section: 01 MR 2:35 pm - 3:50 pm Katharine E. Jensen

PHYS 301 (F) Quantum Physics (QFR)

This course serves as a one-semester introduction to the formalism, and phenomenology of quantum mechanics, beginning with a discussion of the Schrodinger wave equation, the concept of matter waves, and wave-packets. With this introduction as background, we will continue our discussion with a variety of one-dimensional problems such as the particle-in-a-box and the harmonic oscillator. We then extend this work to systems in two and three dimensions, including a detailed discussion of the structure of the hydrogen atom. Along the way we will develop connections between mathematical formalism and physical predictions of the theory. Finally, we conclude the course with a discussion of angular momentum and spins, with applications to atomic physics, entanglement, and quantum information.

Class Format: lecture, three hours per week; laboratory, three hours per week

Requirements/Evaluation: weekly problem sets, laboratory reports / write-ups, a midterm exam, and final exam, all of which have a substantial
quantitative component

**Prerequisites:** PHYS 202 and PHYS/MATH 210 or MATH 309

**Enrollment Limit:** 8 per lab

**Enrollment Preferences:** physics majors

**Expected Class Size:** 24

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** Phys 301 relies heavily upon mathematics and quantitative reasoning in all elements, including problem sets, examinations, and laboratories.

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**Fall 2024**

LEC Section: 01  MWF 9:00 am - 9:50 am  Charlie Doret

LAB Section: 02  M 1:00 pm - 4:00 pm  Charlie Doret, Frederick W. Strauch

LAB Section: 03  W 1:00 pm - 4:00 pm  Charlie Doret, Frederick W. Strauch

LAB Section: 04  R 1:00 pm - 4:00 pm  Charlie Doret, Frederick W. Strauch

**PHYS 302 (S) Statistical Mechanics & Thermodynamics** (QFR)

Macroscopic objects are made up of huge numbers of fundamental particles interacting in simple ways--obeying the Schrödinger equation, Newton's and Coulomb's Laws--and these objects can be described by macroscopic properties like temperature, pressure, magnetization, heat capacity, conductivity, etc. In this course we will develop the tools of statistical physics, which will allow us to predict the cooperative phenomena that emerge in large ensembles of interacting particles. We will apply those tools to a wide variety of physical questions, including the behavior of gases, polymers, heat engines, biological and astrophysical systems, magnets, and electrons in solids.

**Class Format:** lecture/discussion three hours per week and weekly laboratory work

**Requirements/Evaluation:** weekly problem sets and labs, plus exams, all of which have a substantial quantitative component

**Prerequisites:** required: PHYS 201, PHYS/MATH 210 or MATH 309; recommended: PHYS 202, PHYS 301

**Enrollment Limit:** 14 per lab

**Enrollment Preferences:** physics majors

**Expected Class Size:** 25

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** weekly problem sets, exams, and labs, all of which have a substantial quantitative component

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**Spring 2025**

LEC Section: 01  MWF 8:30 am - 9:45 am  Daniel P. Aalberts

LAB Section: 03  R 1:10 pm - 3:50 pm  Daniel P. Aalberts

LAB Section: 02  W 1:10 pm - 3:50 pm  Daniel P. Aalberts

**PHYS 315 (F) Computational Biology** (QFR)

**Cross-listings:** CSCI 315

**Primary Cross-listing**

This course will provide an overview of Computational Biology, the application of computational, mathematical, statistical, and physical problem-solving techniques to interpret the rapidly expanding amount of biological data. Topics covered will include database searching, DNA sequence alignment, clustering, RNA structure prediction, protein structural alignment, methods of analyzing gene expression, networks, and genome assembly using techniques such as string matching, dynamic programming, hidden Markov models, and statistics.

**Requirements/Evaluation:** weekly Python programming assignments, code reviews, problem sets, plus a few quizzes and a final project
Prerequisites: programming experience (e.g., CSCI 136) and mathematics (PHYS/MATH 210 or MATH 150) and physical science (PHYS 142/151, or CHEM 101/15X), or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: if over-enrolled, a questionnaire will be circulated

Expected Class Size: 8

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
CSCI 315(D3) PHYS 315(D3)

Quantitative/Formal Reasoning Notes: problem sets and programming assignments

Attributes: BIGP Courses

Fall 2024
LEC Section: 01 MR 2:35 pm - 3:50 pm Daniel P. Aalberts

PHYS 321 (S) Introduction to Particle Physics (QFR)
The Standard Model of particle physics incorporates special relativity, quantum mechanics, and almost all that we know about elementary particles and their interactions. This course introduces some of the main ideas and phenomena associated with the Standard Model. After a review of relativistic kinematics, we will learn about symmetries in particle physics, relativistic wave equations, elements of quantum field theory, Feynman diagrams, and selected applications of quantum electrodynamics, the weak interactions, and quantum chromodynamics. We will conclude with a discussion of spontaneous symmetry breaking and the Higgs mechanism.

Requirements/Evaluation: weekly problem sets, a midterm exam, and a final exam

Prerequisites: PHYS 301

Enrollment Limit: 20

Enrollment Preferences: By seniority

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Exams and problem sets all have a significant quantitative component.

Spring 2025
LEC Section: 01 TR 11:20 am - 12:35 pm David R. Tucker-Smith

PHYS 402 (S) Applications of Quantum Mechanics (QFR)
This course will explore a number of important topics in the application of quantum mechanics to physical systems, including perturbation theory, the variational principle and the semiclassical interaction of atoms and radiation. The course will finish up with three weeks on quantum optics including an experimental project on non-classical interference phenomena. Applications and examples will be taken mostly from atomic physics with some discussion of solid state systems.

Requirements/Evaluation: weekly problem sets, tutorial participation, presentations, and a final exam, all of which have a substantial quantitative component

Prerequisites: PHYS 301

Enrollment Limit: 10 per sec

Enrollment Preferences: Physics and Astrophysics Majors

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course has weekly problem sets, all of which have a substantial quantitative component.

Spring 2025
TUT Section: T1  F 1:10 pm - 2:25 pm  Betul Pamuk

PHYS 411  (F)  Classical Mechanics  (QFR)
This course will explore advanced topics in classical mechanics. Central ideas include the calculus of variations, the Lagrangian and Hamiltonian formulations of mechanics, phase space, central-force motion, non-inertial reference frames (including implications for physics on a rotating Earth), rigid-body rotations, and non-linear dynamics & chaos, with additional topics from continuum and fluid mechanics as time permits. Numerical and perturbative techniques will be developed and used extensively. We will also examine the ways in which classical mechanics informs other fields of physics. In addition to weekly tutorial meetings the class will meet weekly as a whole to introduce and discuss new material.

Requirements/Evaluation: weekly problem sets, tutorial participation, presentations, a final project, and a final exam, all of which have a substantial quantitative component

Prerequisites: PHYS 202 and PHYS/MATH 210 or MATH 309

Enrollment Limit: 30

Enrollment Preferences: majors

Expected Class Size: 24

Grading: no pass/fail option, no fifth course option

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: weekly problem sets requiring substantial quantitative reasoning using analytical and numerical methods.

Fall 2024
TUT Section: T1  F 1:10 pm - 2:25 pm  Katharine E. Jensen, Frederick W. Strauch

PHYS 451  (F)  Condensed Matter Physics  (QFR)
Condensed matter physics is an important area of current research and serves as the basis for modern electronic technology. We plan to explore the physics of metals, insulators, semiconductors, superconductors, and photonic crystals, with particular attention to structure, thermal properties, energy bands, and electronic properties.

Requirements/Evaluation: weekly readings and problem sets, and exams

Prerequisites: PHYS 301 (may be taken simultaneously); or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Physics majors

Expected Class Size: 6

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3)  (QFR)

Quantitative/Formal Reasoning Notes: serious problem sets

Attributes: MTSC Courses

Fall 2024
SEM Section: 01  MR 1:10 pm - 2:25 pm  Daniel P. Aalberts

POEC 253  (F)  Empirical Methods in Political Economy  (WS)  (QFR)
This course introduces students to common empirical tools used in policy analysis and implementation. Students will develop skills in statistical literacy to become critical consumers of public policy-relevant research. The emphasis in the course is split between an intuitive understanding of statistical foundations, and applications in data visualization and science communication. Through hands-on work with data and critical assessment of existing
empirical social scientific research, students will develop the ability to choose and employ the appropriate tool for a particular research problem, and to understand the limitations of the techniques. Topics to be covered include basic principles of probability; effective data visualization; statistical inference and hypothesis testing; and multiple regression analysis. A particular focus will be placed on understanding causality, the challenges of estimating causal relationships, and the design of evidence-based policy. Throughout the course, the focus will be on public policy applications relevant to the fields of political science, sociology, and public health, as well as to economics.

Requirements/Evaluation: Problem sets, group project, midterm exam, final exam

Prerequisites: MATH 130 or its equivalent; one course in ECON; not open to students who have taken ECON 255

Enrollment Limit: 20

Enrollment Preferences: Political Economy majors, Environmental Policy majors and sophomores

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option

Unit Notes: does not satisfy the econometrics requirement for the Economics major; POEC 253 cannot be substituted for ECON 255, or count as an elective towards the Economics major

Distributions: (D2) (WS) (QFR)

Writing Skills Notes: Students will write 3 coding-intensive data briefs over the course of the semester. Creation of original exhibits from publicly accessible data, use of citation management systems, and clarity in technical writing will be emphasized.

Quantitative/Formal Reasoning Notes: The course teaches econometrics, i.e. statistics as economists use it, with applications in economics, political science, and other fields.

Attributes: POEC Required Courses

Fall 2024
LEC Section: 01 TR 8:30 am - 9:45 am Shyam Raman

PSYC 201 (F)(S) Experimentation and Statistics (QFR)
An introduction to the basic principles of research in psychology. We focus on how to design and execute experiments, analyze and interpret results, and write research reports. Students conduct a series of research studies in different areas of psychology that illustrate basic designs and methods of analysis. You must register for lab and lecture with the same instructor.

Requirements/Evaluation: research reports, exams, and problem sets

Prerequisites: PSYC 101; not open to first-year students except with permission of instructor

Enrollment Limit: 16

Enrollment Preferences: Psychology majors

Expected Class Size: 16

Grading: no pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course has problem sets focused on experimental design and quantitative data analysis. Students will help design and conduct experiments, analyze the data, and report their findings.

Attributes: COGS Related Courses PHLH Statistics Courses

Fall 2024
LAB Section: B4 T 1:00 pm - 4:00 pm Kris N. Kirby
LAB Section: A2 W 1:00 pm - 4:00 pm Kenneth K. Savitsky
LEC Section: A1 MR 1:10 pm - 2:25 pm Kenneth K. Savitsky
LEC Section: B3 TR 9:55 am - 11:10 am Kris N. Kirby

Spring 2025
LEC Section: A1 MR 1:10 pm - 2:25 pm Kenneth K. Savitsky
LAB Section: A2 T 1:00 pm - 4:00 pm Kenneth K. Savitsky
SOC 150  (F)  Data for Justice  (DPE)  (QFR)
Cross-listings: STS 150 / AMST 150 / WGSS 150 / INTR 150
Secondary Cross-listing
This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

Class Format: This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

Requirements/Evaluation: Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

Prerequisites: None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

Enrollment Limit: 18

Enrollment Preferences: Students without prior college-level courses in statistics and programming.

Expected Class Size: 18

Grading: no pass/fail option, no fifth course option

Distributions: (D2)  (DPE)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

Difference, Power, and Equity Notes: This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

Quantitative/Formal Reasoning Notes: This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024
LEC Section: 01  TR 9:55 am - 11:10 am  Chad M. Topaz
LEC Section: 02  TR 11:20 am - 12:35 pm  Chad M. Topaz

STAT 101  (F)(S)  Elementary Statistics and Data Analysis  (QFR)
It is impossible to be an informed citizen in today’s world without an understanding of data. Whether it is opinion polls, unemployment rates, salary differences between men and women, the efficacy of vaccines, etc, we need to be able to interpret and gain information from statistics. This course will introduce the common methods used to analyze and present data with an emphasis on interpretation and informed decision making.

Requirements/Evaluation: weekly homework, quizzes, exams, and a project

Prerequisites: MATH 102 (or demonstrated proficiency on a diagnostic test)

Enrollment Limit: 50
Enrollment Preferences: juniors and seniors

Expected Class Size: 35

Grading: yes pass/fail option, yes fifth course option

Unit Notes: Students with MATH150 but no statistics should enroll in STAT201. Students with AP Stat 4/5 or STAT 101/161 should enroll in STAT 202.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is a quantitative course.

Attributes: COGS Related Courses PHLH Statistics Courses

Fall 2024
LEC Section: 01 MWF 11:00 am - 11:50 am Mihai Stoiciu

Spring 2025
LEC Section: 01 MWF 9:00 am - 9:50 am Anna M. Plantinga

STAT 161 (F)(S) Introductory Statistics for Social Science (QFR)

This course will cover the basics of modern statistical analysis with a view toward applications in the social sciences. Topics include exploratory data analysis, linear regression, basic statistical inference, and elements of probability theory. The course focuses on the application of statistical tools to solve problems, to make decisions, and the use of statistical thinking to understand the world.

Requirements/Evaluation: Weekly homework, quizzes, two midterms and a final exam (midterms include take-home components), and a data analysis project. Students will need to become familiar with the statistical software STATA.

Prerequisites: MATH 130 (or equivalent); not open to students who have completed STAT 101 or equivalent

Enrollment Limit: 40

Enrollment Preferences: Economics majors, sophomores

Expected Class Size: 40

Grading: yes pass/fail option, no fifth course option

Unit Notes: Students with calculus background should consider STAT 201. Students without any calculus background should consider STAT 101. Students with AP Stat 4 or 5 should consider Stat 202. Please refer to the placement chart on the Math&Stat department website for more information.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Reasoning with data

Attributes: PHLH Statistics Courses

Fall 2024
LEC Section: 02 MWF 11:00 am - 11:50 am Duncan A. Clark
LEC Section: 01 MWF 9:00 am - 9:50 am Duncan A. Clark

Spring 2025
LEC Section: 01 MWF 10:00 am - 10:50 am Duncan A. Clark
LEC Section: 02 MWF 12:00 pm - 12:50 pm Duncan A. Clark

STAT 201 (F)(S) Statistics and Data Analysis (QFR)

Statistics can be viewed as the art and science of turning data into information. Real world decision-making, whether in business or science, is often based on data and the perceived information it contains. Sherlock Holmes, when prematurely asked the merits of a case by Dr. Watson, snapped back, "Data, data, data! I can't make bricks without clay." In this course, we will study the basic methods by which statisticians attempt to extract information from data. These will include many of the standard tools of statistical inference such as hypothesis testing, confidence intervals, and linear regression as well as exploratory and graphical data analysis techniques. This is an accelerated introductory statistics course that involves computational programming and incorporates modern statistical techniques.

Requirements/Evaluation: weekly homework and projects, midterm exams, and a final exam.
Prerequisites: MATH 150 or equivalent; not open to students who have completed STAT 101 or STAT 161 or equivalent

Enrollment Limit: 40

Enrollment Preferences: Prospective Statistics majors, students for whom the course is a major prerequisite, and seniors

Expected Class Size: 40

Grading: yes pass/fail option, yes fifth course option

Unit Notes: Students with AP Stat 4/5 or STAT 101/161 should enroll in STAT 202. Students with no calc or stats background should enroll in STAT 101. Students with MATH 140 but no statistics should enroll in STAT 161.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Students will learn to choose, carry out, interpret, and communicate analyses of data.

Attributes: COGS Related Courses PHLH Statistics Courses

Fall 2024
LEC Section: 01 TF 1:10 pm - 2:25 pm Elizabeth M. Upton

Spring 2025
LEC Section: 01 TF 1:10 pm - 2:25 pm Elizabeth M. Upton

STAT 202 (F)(S) Introduction to Statistical Modeling (QFR)

Data come from a variety of sources: sometimes from planned experiments or designed surveys, sometimes by less organized means. In this course we’ll explore the kinds of models and predictions that we can make from both kinds of data, as well as design aspects of collecting data. We’ll focus on model building, especially multiple regression, and talk about its potential to answer questions about the world -- and about its limitations. We’ll emphasize applications over theory and analyze real data sets throughout the course.

Requirements/Evaluation: Homework problems; quizzes; exams; a final project (on a topic that interests you!). Participation matters! Engagement with your peers is an important part of learning, of being a statistician in the Real World…and of your evaluation in this course. While your assignments will be submitted (and graded) individually, you’ll be responsible for giving and receiving peer feedback, contributing to class discussions, and working together with classmates on practice problems.

Prerequisites: MATH 140 and STAT 101/161/201/AP Statistics 4/5, or permission of instructor.

Enrollment Limit: 40

Enrollment Preferences: Prospective Statistics majors and more senior students

Expected Class Size: 25

Grading: yes pass/fail option, yes fifth course option

Unit Notes: Students with a 4 on the AP Stats exam should contact the department for proper placement. Students with STAT 201 are strongly encouraged to take STAT 346 or other 300-level statistics electives.

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course uses mathematical tools and computing programs to create models, make predictions, assess uncertainty, and describe data. We’ll also emphasize choosing appropriate mathematical tools and interpreting their results in a real-world context.

Attributes: PHLH Statistics Courses

Fall 2024
LEC Section: 02 TR 9:55 am - 11:10 am Anna C. Neufeld
LEC Section: 01 TR 8:30 am - 9:45 am Anna C. Neufeld

Spring 2025
LEC Section: 01 TR 8:30 am - 9:45 am Anna C. Neufeld
LEC Section: 02 TF 1:10 pm - 2:25 pm Xizhen Cai

STAT 335 (S) Introduction to Biostatistics and Epidemiology (QFR)

Epidemiology is the study of disease and disability in human populations, while biostatistics focuses on the development and application of statistical
methods to address questions that arise in medicine, public health, or biology. This course will begin with epidemiological study designs and core concepts in epidemiology, followed by key statistical methods in public health research. Topics will include multiple regression, analysis of categorical data (two sample methods, sets of 2x2 tables, RxC tables, and logistic regression), survival analysis (Cox proportional hazards model), and if time permits, a brief introduction to regression with correlated data.

Requirements/Evaluation: Evaluation will be primarily based on weekly assignments (regular homework or mini-projects), two midterm exams, and a final exam.

Prerequisites: Stat 201 or Stat 202, or permission of instructor (prior experience should include a working understanding of multiple linear regression, the basics of statistical inference, and R).

Enrollment Limit: 20

Enrollment Preferences: Statistics majors and prospective majors who have not yet taken Stat 346; public health concentrators

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Students will learn how to choose, implement, and interpret statistical analyses relevant to public health studies.

Attributes: PHLH Statistics Courses

Spring 2025

LEC Section: 01  MWF 12:00 pm - 12:50 pm  Anna M. Plantinga

STAT 341  (F)(S) Probability  (QFR)

Cross-listings: MATH 341

Secondary Cross-listing

The historical roots of probability lie in the study of games of chance. Modern probability, however, is a mathematical discipline that has wide applications in a myriad of other mathematical and physical sciences. Drawing on classical gaming examples for motivation, this course will present axiomatic and mathematical aspects of probability. Included will be discussions of random variables (both discrete and continuous), distribution and expectation, independence, laws of large numbers, and the well-known Central Limit Theorem. Many interesting and important applications will also be presented, including some from classical Poisson processes, random walks and Markov Chains.

Requirements/Evaluation: homework, classwork, and exams

Prerequisites: MATH 150 and MATH 250 or permission of the instructor

Enrollment Limit: 50

Enrollment Preferences: Priority will be given to Mathematics majors and to Statistics Majors.

Expected Class Size: 20

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STAT 341(D3) MATH 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2024

LEC Section: 01  MWF 12:00 pm - 12:50 pm  Mihai Stoiciu

Spring 2025

LEC Section: 01  TR 9:55 am - 11:10 am  Steven J. Miller

STAT 342  (S) Introduction to Stochastic Processes  (QFR)

Stochastic processes are mathematical models for random phenomena evolving in time or space. Examples include the number of people in a queue
at time $t$ or the accumulated claims paid by an insurance company in an interval of time $t$. This course introduces the basic concepts and techniques of stochastic processes used to construct models for a variety of problems of practical interest. The theory of Markov chains will guide our discussion as we cover topics such as martingales, random walks, Poisson process, birth and death processes, and Brownian motion.

**Requirements/Evaluation:** weekly homework/labs, classwork, and exams

**Prerequisites:** STAT 341

**Enrollment Limit:** 30

**Enrollment Preferences:** senior Statistics majors

**Expected Class Size:** 15

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This is a statistics class with a focus on mathematical skills and translating real world phenomena into mathematical descriptions.

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**Spring 2025**

LEC Section: 01    TF 2:35 pm - 3:50 pm     Elizabeth M. Upton

**STAT 344 (S) Statistical Design of Experiments** (QFR)

When you hear the word experiment you might be picturing white lab coats and pipettes, but businesses, especially e-commerce, are constantly experimenting as well. How do you get the most out of both scientific and business investigations? By doing the right experiment in the first place. We'll explore the techniques used to plan experiments that are both efficient and statistically sound. We'll learn how to analyze the data that come from these experiments and the conclusions we can draw from that analysis. We'll look at both classical tools like fractional factorial designs as well as optimal design, and see how these two frameworks differ in their philosophy and in what they can do. Throughout the course, we'll make extensive use of both R and JMP software to work with real-world data.

**Requirements/Evaluation:** Homework problems--both individual and in groups, midterm, final, and projects (on topics that interest you!).

**Prerequisites:** STAT 161 or 201 or 202, or equivalent, and Math 140 or equivalent, or permission of instructor

**Enrollment Limit:** 20

**Enrollment Preferences:** Statistics majors, seniors, juniors, sophomores, first years

**Expected Class Size:** 15

**Grading:** yes pass/fail option, yes fifth course option

**Distributions:** (D3) (QFR)

**Quantitative/Formal Reasoning Notes:** This course uses mathematical tools and computing programs to design experiments, analyze their results, and assess their effectiveness. We'll also emphasize choosing appropriate mathematical tools and interpreting their results in a real-world context.

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**Spring 2025**

LEC Section: 01    MWF 10:00 am - 10:50 am     Richard D. De Veaux

**STAT 346 (F)(S) Regression Theory and Applications** (QFR)

This course focuses on the building of empirical models through data in order to predict, explain, and interpret scientific phenomena. Regression modeling is the most widely used method for analyzing and predicting a response data and for understand the relationship with explanatory variables. This course provides both theoretical and practical training in statistical modeling with particular emphasis on simple linear and multiple regression, using R to develop and diagnose models. The course covers the theory of multiple regression and diagnostics from a linear algebra perspective with emphasis on the practical application of the methods to real data sets. The data sets will be taken from a wide variety of disciplines.

**Requirements/Evaluation:** Weekly homework, quizzes, theory and data analysis exams, and final course project.

**Prerequisites:** MATH/STAT 341, MATH 250, and at least one of STAT 201 or 202. Or permission of the instructor.

**Enrollment Limit:** 30

**Enrollment Preferences:** Statistics Majors
Expected Class Size: 20
Grading: yes pass/fail option, no fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course prepares students in the use of quantitative methods for the modeling, prediction and understanding of scientific phenomena.

Fall 2024
LEC Section: 01  TR 9:55 am - 11:10 am  Xizhen Cai

Spring 2025
LEC Section: 01  TR 9:55 am - 11:10 am  Xizhen Cai

STAT 355  (F)  Multivariate Statistical Analysis  (QFR)
To better understand complex processes, we study how variables are related to one another and how they work in combination. In addition, we want to make inferences about more than one variable at a time. Elementary statistical methods might not apply. In this course, we study the tools and the intuition that are necessary to analyze and describe such datasets with more than multiple variables. Topics covered will include data visualization techniques for data sets with more variables, clustering algorithms, parametric and non-parametric techniques to estimate joint distributions, techniques for combining variables, performing dimension reduction, and making inferences.

Requirements/Evaluation: Homework, projects, quizzes, and exams.
Prerequisites: MATH 250, and STAT 346 or permission of instructor
Enrollment Limit: 15
Enrollment Preferences: Juniors/seniors
Expected Class Size: 10
Grading: yes pass/fail option, no fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is an advanced statistics class with prerequisites that are QFR courses

Fall 2024
LEC Section: 01  TF 1:10 pm - 2:25 pm  Xizhen Cai

STAT 360  (F)  Statistical Inference  (QFR)
How do we estimate unknown parameters and express the uncertainty we have in our estimate? Is there an estimator that works best? Many topics from introductory statistics such as random variables, the central limit theorem, point and interval estimation and hypotheses testing will be revisited and put on a more rigorous mathematical footing. The focus is on maximum likelihood estimators and their properties. Bayesian and computer intensive resampling techniques (e.g., the bootstrap) will also be considered.

Requirements/Evaluation: Homework, Quizzes, Exams
Prerequisites: MATH 250, STAT 201 or 202, STAT 341
Enrollment Limit: 15
Enrollment Preferences: Statistics majors
Expected Class Size: 15
Grading: no pass/fail option, yes fifth course option
Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: A rigorous mathematical course laying the foundation for reasoning with data

Fall 2024
LEC Section: 01  MWF 10:00 am - 10:50 am  Richard D. De Veaux
In both science and industry today, the ability to collect and store data can outpace our ability to analyze it. Traditional techniques in statistics are often unable to cope with the size and complexity of today's data bases and data warehouses. New methodologies in Statistics have recently been developed, designed to address these inadequacies, emphasizing visualization, exploration and empirical model building at the expense of traditional hypothesis testing. In this course we will examine these new techniques and apply them to a variety of real data sets.

Class Format: Students cannot take both STAT 315 and STAT 442. Only one of the two can be taken for credit.

Requirements/Evaluation: class participation, weekly homework, exams and an end-of-term project

Prerequisites: MATH/STAT 341 and STAT 346, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: Statistics majors, juniors and seniors. Students cannot take both STAT 315 and STAT 442. Only one of the two can be taken for credit.

Expected Class Size: 15

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced statistics class involving theory and application of statistical methods to data.

Spring 2025

LEC Section: 01    MR 2:35 pm - 3:50 pm       Anna C. Neufeld

STAT 458  (F)  Generalized Linear Models- Theory and Applications  (QFR)

This course will explore generalized linear models (GLMs)--the extension of linear models, discussed in Stat346, to response variables that have specific non-normal distributions, such as counts and proportions. We will consider the general structure and theory of GLMs and see their use in a range of applications. As time permits, we will also examine extensions of these models for clustered data such as mixed effects models and generalized estimating equations.

Requirements/Evaluation: Weekly homework consisting of theoretical exercises and data analyses carried out in R. Short frequent quizzes and one midterm (with an in-class and take-home component). Final project and final exam.

Prerequisites: STAT 346, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: Seniors and Statistics majors

Expected Class Size: 10

Grading: yes pass/fail option, yes fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an intensive statistics course, involving theoretical and mathematical reasoning as well as the application of mathematical ideas to data using software.

Fall 2024

LEC Section: 01    TF 2:35 pm - 3:50 pm       Elizabeth M. Upton

STS 150  (F)  Data for Justice  (DPE) (QFR)

Cross-listings: AMST 150 / SOC 150 / WGSS 150 / INTR 150

Secondary Cross-listing

This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for
social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts
dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully
promote justice is more important than ever.

**Class Format:** This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect
substantial time devoted to in-class collaboration.

**Requirements/Evaluation:** Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a
non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

**Prerequisites:** None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to
engage intensively with data and computing are essential.

**Enrollment Limit:** 18

**Enrollment Preferences:** Students without prior college-level courses in statistics and programming.

**Expected Class Size:** 18

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

**Difference, Power, and Equity Notes:** This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice,
diversity and inclusion in arts and media, education equity. We will consider race, gender, LGTBQ+, disability, and other axes of identity. Additionally,
we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

**Quantitative/Formal Reasoning Notes:** This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on
essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024

LEC Section: 02    TR 11:20 am - 12:35 pm    Chad M. Topaz

LEC Section: 01    TR 9:55 am - 11:10 am    Chad M. Topaz

STS 363  (S) Data for Justice Research Practicum   (DPE) (QFR)

**Cross-listings:** WGSS 363 / INTR 350 / AMST 363

**Secondary Cross-listing**

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this
inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of
social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education
equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this
course is to build skills for advanced research.

**Class Format:** This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the
instructor. The primary modality of work is peer collaboration.

**Requirements/Evaluation:** To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based,
ungraded assessment framework.

**Prerequisites:** INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the
instructor.

**Enrollment Limit:** 10

**Enrollment Preferences:** Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the
instructor's preregistration survey (contact the instructor for link).

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
**Difference, Power, and Equity Notes:** Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

**Quantitative/Formal Reasoning Notes:** Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 02  TR 11:20 am - 12:35 pm  Chad M. Topaz
SEM Section: 01  TR 9:55 am - 11:10 am  Chad M. Topaz

**WGSS 150  (F)  Data for Justice  (DPE)  (QFR)**

**Cross-listings:** STS 150 / AMST 150 / SOC 150 / INTR 150

**Secondary Cross-listing**

This course is a unique and inclusive introduction to data science where quantitative thinking, programming, and social justice intertwine. We will build our data science skills using R, a popular open-source data science tool. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration. But rather than divorcing these techniques from the social issues they can help illuminate, we ground them in a social justice context. Overall, we will apply data science skills to topics drawn from criminal justice, environmental justice, diversity and inclusion in arts and media, education equity, and much more, with the goal of growing our collective capacity to use data science as a tool for social good. During a time when humans are increasingly subjugated to data-driven algorithmic decisions, when there are social media accounts dedicated to highlighting misuses of data, and when artificial intelligence makes faking data a nearly trivial task, using data to ethically and carefully promote justice is more important than ever.

**Class Format:** This course is taught in a highly interactive format and will frequently use a flipped-classroom approach. Students should expect substantial time devoted to in-class collaboration.

**Requirements/Evaluation:** Students will complete regularly assigned activities, problem sets, and other assessments. To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based approach.

**Prerequisites:** None. This course assumes no prior knowledge of data science or R programming. An interest in social justice and a willingness to engage intensively with data and computing are essential.

**Enrollment Limit:** 18

**Enrollment Preferences:** Students without prior college-level courses in statistics and programming.

**Expected Class Size:** 18

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D2)  (DPE)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

STS 150(D2) AMST 150(D2) SOC 150(D2) WGSS 150(D2) INTR 150(D2)

**Difference, Power, and Equity Notes:** This course uses data science as a lens for injustice in spheres such as criminal justice, environmental justice, diversity and inclusion in arts and media, education equity. We will consider race, gender, LGBTQ+, disability, and other axes of identity. Additionally, we will adopt a data-critical perspective, thinking about how social forces shape data and our understanding of it.

**Quantitative/Formal Reasoning Notes:** This course teaches quantitative tools in R, a widely-adopted data science platform. We will focus on essential stages of data analysis, including data acquisition, cleaning, wrangling, visualization, and exploration.

Fall 2024

LEC Section: 01  TR 9:55 am - 11:10 am  Chad M. Topaz
LEC Section: 02  TR 11:20 am - 12:35 pm  Chad M. Topaz

**WGSS 363  (S)  Data for Justice Research Practicum  (DPE)  (QFR)**

**Cross-listings:** STS 363 / INTR 350 / AMST 363
Secondary Cross-listing

Civil rights activist, educator, and investigative journalist Ida B. Wells said that "the way to right wrongs is to shine the light of truth upon them." In this inclusive, collaborative, research-based course, students will bring statistical, computational, and/or mathematical approaches to bear on issues of social justice. Guided closely by the instructor, students will work in groups to carry out original research in an area such as criminal justice, education equity, environmental justice, health care equity, economic justice, or inclusion in arts/media. Prior research experience is not required; one goal of this course is to build skills for advanced research.

Class Format: This course is an intensive research practicum. Formation of research groups and selection of research topics will be facilitated by the instructor. The primary modality of work is peer collaboration.

Requirements/Evaluation: To move towards a non-hierarchical, transparent, and egalitarian grading system, the instructor adopts a mastery-based, ungraded assessment framework.

Prerequisites: INTR 150 (Data for Justice), or prior equivalent exposure to computing, statistics, and social justice topics as approved by the instructor.

Enrollment Limit: 10

Enrollment Preferences: Students who have a declared major in Division I or II, who meet the prerequisites of the course, and who fill out the instructor's preregistration survey (contact the instructor for link).

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D2) (DPE) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

WGSS 363(D2) STS 363(D2) INTR 350(D2) AMST 363(D2)

Difference, Power, and Equity Notes: Students will research issues of social justice in areas such as criminal justice, arts/media, environmental justice, education, and health care, and along identity axes such as gender, race/ethnicity, disability status, and sexual orientation.

Quantitative/Formal Reasoning Notes: Students will use multiple mathematical, statistical, and computational frameworks to acquire, model, and analyze real-world data.

Spring 2025

SEM Section: 01 TR 9:55 am - 11:10 am Chad M. Topaz

SEM Section: 02 TR 11:20 am - 12:35 pm Chad M. Topaz