

QUANTITATIVE/FORMAL REASONING (QFR)

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.

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 6 afternoon labs. 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

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 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Marek Demianski

LAB Section: 02 M 1:10 pm - 4:00 pm Kevin Flaherty

LAB Section: 03 R 1:10 pm - 4:00 pm Kevin Flaherty

ASTR 211 (S) Astronomical Observing and Data Analysis (QFR)

How do astronomers make scientific measurements for objects that are light-years away from Earth? This course will introduce the basics of telescopes and observations and will give students hands-on training in the techniques astronomers use to obtain, process, and analyze scientific data. We will discuss observation planning, CCD detectors, signal statistics, image processing, and photometric and spectroscopic observations. We will begin by focusing on ground-based optical observations and will move on to non-optical observations, both electromagnetic (e.g., radio waves, X-rays) and non-electromagnetic (e.g., gravitational waves, neutrinos). Throughout the course, students will use computational techniques to work with real astronomical data, taken with our 24" telescope and from data archives.

Class Format: discussion, computer lab work, and observing

Requirements/Evaluation: weekly problem sets, lab work, and observing projects

Prerequisites: MATH 150 or 151; prior experience with Unix and computer programming is helpful, but not required

Enrollment Limit: 14

Enrollment Preferences: Astronomy or Astrophysics majors

Expected Class Size: 8

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course requires regular problem sets. Labs require computer programming and statistical and graphical analyses of data.

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Anne Jaskot

LAB Section: 02 W 1:10 pm - 3:50 pm Kevin Flaherty

ASTR 402 (F) 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.

Fall 2023

TUT Section: T1 TBA Anne Jaskot

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 2024

IND Section: 01 TBA Protik K. Majumder

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

Cross-listings: CHEM 321 / BIOL 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: 16/lab

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:

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

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

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

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:

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

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

Spring 2024

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

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

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.

Fall 2023

LEC Section: 01 MWF 11:00 am - 11:50 am David W. Loehlin

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

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

LAB Section: 04 R 1:00 pm - 3:50 pm Derek Dean

LAB Section: 05 M 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

Unit Notes: satisfies the distribution requirement for the Biology major

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 t-tests, chi-square analysis, and regression.

Fall 2023

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 (F) 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.

Fall 2023

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

LAB Section: 02 T 1:00 pm - 3:50 pm Luana S. Maroja

LAB Section: 03 W 1:00 pm - 3:50 pm Luana S. Maroja

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

Cross-listings: CHEM 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: 16/lab

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:

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

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

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

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

Cross-listings: CHEM 322 / BIMO 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:

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

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

Spring 2024

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

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Sarah L. Goh

LEC Section: 02 MWF 10:00 am - 10:50 am Katie M. Hart

LAB Section: 03 T 1:00 pm - 4:00 pm Katie M. Hart

LAB Section: 04 W 1:00 pm - 4:00 pm Sarah L. Goh

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, ethics, 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).

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.

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Bob Rawle

LEC Section: 02 MWF 11:00 am - 11:50 am Ben L. Augenbraun

LAB Section: 03 M 1:00 pm - 5:00 pm Bob Rawle

LAB Section: 04 T 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 05 W 1:00 pm - 5:00 pm Stephanie Christau

LAB Section: 06 R 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 07 M 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 08 Cancelled

LAB Section: 09 W 1:00 pm - 5:00 pm Ben L. Augenbraun

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Sarah L. Goh, Amy Gehring

LEC Section: 02 MWF 10:00 am - 10:50 am Amy Gehring, Sarah L. Goh

LAB Section: 03 M 1:00 pm - 5:00 pm Sarah L. Goh

LAB Section: 04 T 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 05 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 06 R 1:00 pm - 5:00 pm B Thuronyi

CHEM 200 (S) Advanced Chemical Concepts (QFR)

Class of 2027 ONLY (Class of 2024, 2025, 2026 see CHEM 256). 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: 45; 16/lab

Enrollment Preferences: first-year students, then sophomores

Expected Class Size: 45/lecture

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.

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Enrique Peacock-López

LEC Section: 02 MWF 10:00 am - 10:50 am Enrique Peacock-López

LAB Section: 03 M 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 04 T 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 05 W 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 06 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 07 T 8:00 am - 12:00 pm Laura R. Strauch

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: 16/lab

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:

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

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

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

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

Cross-listings: BIOL 322 / BIMO 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:

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

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

Spring 2024

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

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

CHEM 368 (S) Computational Chemistry and Molecular Spectroscopy (QFR)

This tutorial provides an introduction to the principles of computational quantum mechanics and their application to problems of chemical interest such as chemical bonding, chemical reactivity, and molecular spectroscopy. Emphasis is placed upon modern electronic structure calculations, their fundamentals, practical considerations, interpretation, and applications to current research questions. Under guidance in sessions and through independent work, students will use computational methods to explore assigned weekly research problems. The research results will be presented to and discussed with the tutorial partner at the end of each week.

Requirements/Evaluation: tutorial participation, presentations, and submitted papers

Prerequisites: CHEM 361 or equivalent background in Physics

Enrollment Limit: 10

Enrollment Preferences: Chemistry majors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

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

Spring 2024

TUT Section: T1 Cancelled

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:

COGS 224(D2) PHIL 221(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).

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 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 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Stephen N. Freund

LEC Section: 02 MWF 11:00 am - 11:50 am Katie A. Keith

LAB Section: 03 M 1:00 pm - 2:30 pm Stephen N. Freund

LAB Section: 04 M 2:30 pm - 4:00 pm Stephen N. Freund

LAB Section: 05 T 1:00 pm - 2:30 pm Katie A. Keith

LAB Section: 06 T 2:30 pm - 4:00 pm Katie A. Keith

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.

Fall 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Mark Hopkins
LEC Section: 02 MWF 10:00 am - 10:50 am Iris Howley
LEC Section: 03 MWF 11:00 am - 11:50 am Iris Howley
LAB Section: 04 M 1:00 pm - 2:30 pm Iris Howley
LAB Section: 05 M 1:00 pm - 2:30 pm Mark Hopkins
LAB Section: 06 M 2:30 pm - 4:00 pm Iris Howley
LAB Section: 07 T 1:00 pm - 2:30 pm Iris Howley
LAB Section: 08 T 1:00 pm - 2:30 pm Mark Hopkins
LAB Section: 09 T 2:30 pm - 4:00 pm Iris Howley

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Bill K. Jannen
LEC Section: 02 MWF 10:00 am - 10:50 am Shikha Singh
LEC Section: 03 MWF 11:00 am - 11:50 am Shikha Singh
LAB Section: 04 M 1:00 pm - 2:30 pm Shikha Singh
LAB Section: 05 M 1:00 pm - 2:30 pm Bill K. Jannen
LAB Section: 06 M 2:30 pm - 4:00 pm Shikha Singh
LAB Section: 07 T 1:00 pm - 2:30 pm Shikha Singh
LAB Section: 08 T 2:30 pm - 4:00 pm Bill K. Jannen
LAB Section: 09 T 2:30 pm - 4:00 pm Shikha Singh

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.

Fall 2023

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 2024

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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Bill K. Jannen

LEC Section: 02 MWF 11:00 am - 11:50 am Bill K. Jannen

LAB Section: 03 W 1:00 pm - 2:30 pm Bill K. Jannen

LAB Section: 04 W 2:30 pm - 4:00 pm Bill K. Jannen

LAB Section: 05 R 1:00 pm - 2:30 pm Bill K. Jannen

LAB Section: 06 R 2:30 pm - 4:00 pm Bill K. Jannen

Spring 2024

LEC Section: 01 MWF 12:00 pm - 12:50 pm 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 2023

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

Spring 2024

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 331 (F) Introduction to Computer Security (QFR)

This class explores common vulnerabilities in computer systems, how attackers exploit them, and how systems engineers design defenses to mitigate them. The goal is to be able to recognize potential vulnerabilities in one's own software and to practice defensive design. Hands-on experience writing assembly language and C code to inspect and modify the low-level operation of running programs is emphasized. Finally, regular reading and writing assignments round out the course to help students understand the cultural and historical background of the computer security "arms race."

Class Format: This course has twice-weekly lecture meetings as well as a weekly lab meeting.

Requirements/Evaluation: weekly reading responses, lab assignments, midterm exam, and final project

Prerequisites: CSCI 237

Enrollment Limit: 24(12/lab)

Enrollment Preferences: upper-level students

Expected Class Size: 24

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

Materials/Lab Fee: A fee of \$75-\$100 will be added to the term bill to cover the purchase of a Raspberry Pi computer and accessories.

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.

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Daniel W. Barowy

LAB Section: 02 T 1:00 pm - 2:30 pm Daniel W. Barowy

LAB Section: 03 T 2:30 pm - 4:00 pm Daniel W. Barowy

CSCI 334 (F)(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.

Fall 2023

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

Spring 2024

LEC Section: 01 TR 9:55 am - 11:10 am Daniel W. Barowy

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 2024

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 361 (S) 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 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.

Class Format: Students should sign up for lecture and one conference section.

Requirements/Evaluation: online multiple choice and short answer questions, weekly problem sets in groups, a research project, and a final

examination

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

Enrollment Limit: 60; 12/con

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 60

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.

Spring 2024

LEC Section: 01 MR 2:35 pm - 3:50 pm Aaron M. Williams

CON Section: 02 W 11:00 am - 12:00 pm Aaron M. Williams

CON Section: 03 W 12:00 pm - 1:00 pm Aaron M. Williams

CON Section: 04 W 1:00 pm - 2:00 pm Aaron M. Williams

CON Section: 05 W 2:00 pm - 3:00 pm Aaron M. Williams

CON Section: 06 W 3:00 pm - 4:00 pm Aaron M. Williams

CSCI 374 (F) Machine Learning (QFR)

Machine learning is a field that derives from artificial intelligence and statistics, and is concerned with the design and analysis of computer algorithms that "learn" automatically through the use of data. Computer algorithms are capable of discerning subtle patterns and structure in the data that would be practically impossible for a human to find. As a result, real-world decisions, such as treatment options and loan approvals, are being increasingly automated based on predictions or factual knowledge derived from such algorithms. This course explores topics in supervised learning (e.g., random forests and neural networks), unsupervised learning (e.g., k-means clustering and expectation maximization), and possibly reinforcement learning (e.g., Q-learning and temporal difference learning.) It will also introduce methods for the evaluation of learning algorithms (with an emphasis on analysis of generalizability and robustness of the algorithms to distribution/environmental shift), as well as topics in computational learning theory and ethics.

Requirements/Evaluation: Presentations, problem sets, programming exercises, empirical analyses of algorithms, critical analysis of current literature; the final two weeks are focused on a project of the student's design.

Prerequisites: CSCI 136 and CSCI 256 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: This course heavily relies on discrete mathematics, calculus, and elementary statistics. Students will be proving theorems, among many other mathematically oriented assignments. Additionally, they will be programming, which involves analytical and logical thinking.

Fall 2023

LEC Section: 01 MR 1:10 pm - 2:25 pm Rohit Bhattacharya

LEC Section: 02 MR 2:35 pm - 3:50 pm Rohit Bhattacharya

CSCI 379 (S) Causal Inference (QFR)

Does X cause Y? If so, how? And what is the strength of this causal relation? Seeking answers to such causal (as opposed to associational) questions is a fundamental human endeavor; the answers we find can be used to support decision-making in various settings such as healthcare and public policy. But how does one tease apart causation from association--early in our statistical education we are taught that "correlation does not imply causation." In this course, we will re-examine this phrase and learn how to reason with confidence about the validity of causal conclusions drawn from messy real-world data. We will cover core topics in causal inference including causal graphical models, unsupervised learning of the structure of these models, expression of causal quantities as functions of observed data, and robust/efficient estimation of these quantities using statistical and machine learning methods. Concepts in the course will be contextualized via regular case studies.

Requirements/Evaluation: Problem sets, programming exercises, empirical analyses, case studies, and a final project.

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

Enrollment Limit: 24

Enrollment Preferences: Computer science majors and prospective majors.

Expected Class Size: 24

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course heavily relies on discrete mathematics, algorithms, and elementary statistics. There will be regular assignments requiring rigorous quantitative or formal reasoning.

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Rohit Bhattacharya

CSCI 381 (S) 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.

Spring 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Mark Hopkins

LEC Section: 02 MWF 12:00 pm - 12:50 pm Mark Hopkins

CSCI 432 (F) Operating Systems (QFR)

This course explores the design and implementation of computer operating systems. Topics include historical aspects of operating systems development, systems programming, process scheduling, synchronization of concurrent processes, virtual machines, memory management and virtual memory, I/O and file systems, system security, os/architecture interaction, and distributed operating systems.

Requirements/Evaluation: several implementation projects that will include significant programming, as well as written homework, and up to two exams

Prerequisites: CSCI 237 and either CSCI 256 or 334

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/or programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Jeannie R Albrecht

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.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Susan Godlonton

LEC Section: 02 TR 11:20 am - 12:35 pm Owen Thompson

LEC Section: 03 TF 1:10 pm - 2:25 pm Katie Gutierrez

LEC Section: 04 TF 2:35 pm - 3:50 pm Katie Gutierrez

LEC Section: 05 MR 1:10 pm - 2:25 pm Owen Thompson

LEC Section: 06 MR 2:35 pm - 3:50 pm Owen Thompson

Spring 2024

LEC Section: 01 TF 1:10 pm - 2:25 pm Matthew Chao

LEC Section: 02 TF 2:35 pm - 3:50 pm Matthew Chao

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.

Fall 2023

LEC Section: 01 MR 1:10 pm - 2:25 pm Caitlin E. Hegarty

LEC Section: 02 MR 2:35 pm - 3:50 pm Caitlin E. Hegarty

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Sara LaLumia

LEC Section: 02 MR 2:35 pm - 3:50 pm Sara LaLumia

LEC Section: 03 TR 8:30 am - 9:45 am Will Olney

LEC Section: 04 MWF 9:00 am - 9:50 am Neal J. Rappaport

LEC Section: 05 MWF 10:00 am - 10:50 am Neal J. Rappaport

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

Cross-listings: ENVI 213

Primary Cross-listing

We'll use economics to examine why we harm the environment and overuse natural resources, and what we can do about it. We'll study cost benefit analysis, pollution in general, climate change, 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 involved in 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)

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

Spring 2024

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

ECON 232 (F) 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.

Fall 2023

LEC Section: 01 TR 8:30 am - 9:45 am Neal J. Rappaport

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 2023

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

LEC Section: 02 MWF 11:00 am - 12:15 pm Sara LaLumia

LEC Section: 03 TR 11:20 am - 12:35 pm Neal J. Rappaport

LEC Section: 04 MR 1:10 pm - 2:25 pm Neal J. Rappaport

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Greg Phelan

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 2023

LEC Section: 01 TR 9:55 am - 11:10 am Burak Uras

LEC Section: 02 TR 11:20 am - 12:35 pm Burak Uras

Spring 2024

LEC Section: 01 MWF 8:30 am - 9:45 am Gregory P. Casey

LEC Section: 02 MWF 11:00 am - 12:15 pm Gregory P. Casey

LEC Section: 03 TR 11:20 am - 12:35 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.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Shyam Raman

LEC Section: 02 TR 8:30 am - 9:45 am David J. Zimmerman

LEC Section: 03 MWF 11:00 am - 12:15 pm Shyam Raman

Spring 2024

LEC Section: 01 Cancelled

LEC Section: 02 TR 9:55 am - 11:10 am Anand V. Swamy

LEC Section: 03 W 7:00 pm - 9:40 pm Thursday Org Mtg 6:30 pm - 6:55 pm David J. Zimmerman

ECON 360 (F) Monetary Economics (QFR)

This course covers a range of theoretical and applied issues bearing on monetary policy as conducted in the U.S. and abroad. Topics to be covered include: the causes of inflation, how central banks manage interest rates, the channels through which monetary policy affects the economy, and the costs and benefits of imposing rules on the conduct of policy. The class will also touch on a number of current issues facing central banks, such as unconventional monetary policy and cryptocurrencies.

Requirements/Evaluation: Two exams, a research paper and/or class presentation

Prerequisites: ECON 252 and 255. Multivariate calculus (MATH 150 or 151) is recommended but not required

Enrollment Limit: 20

Enrollment Preferences: junior and senior Economics majors

Expected Class Size: 20

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: The course entails the use of mathematical economic models, the presentation of quantitative information, and the interpretation of statistical analysis.

Fall 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Kenneth N. Kuttner

ECON 367 (S) The Political Economy of Social Insurance (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) (QFR)

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

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 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 endogeneous systems, and will then focus on associated methods for analysis of short 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 fields 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. Credit may not be earned for both ECON 371 and ECON 356.

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 2023

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

ECON 384 (S) 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. Additional topics may include issues in corporate risk management, corporate governance and corporate restructuring, such as mergers and acquisitions.

Class Format: Lecture / discussion

Requirements/Evaluation: Class participation, short assignments, and exams

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

Enrollment Limit: 28

Enrollment Preferences: Economics majors; seniority

Expected Class Size: 28

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

Distributions: (D2) (QFR)

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

Spring 2024

LEC Section: 01 MWF 8:30 am - 9:45 am 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

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,

Fall 2023

LEC Section: 01 Cancelled

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 514(D2) ECON 389(D2)

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

Spring 2024

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

ECON 475 (S) Advanced Economic Theory (QFR)

This course studies advanced topics in micro and macro economic theory. A major focus is on the mathematical underpinnings of advanced modern economics, with a particular emphasis on proofs. Topics may include existence of Nash equilibria, games of incomplete information, equilibrium refinement and selection, global games, Bayesian persuasion, Mirrless taxation, dynamic programming, existence of general equilibrium, recursive equilibria, stochastic models in continuous time, and others. The focus of this class is primarily on mathematical formalism, rigor, and proofs. These tools are essential components of any graduate program in economics. Students who wish to see pure math theorems applied to other fields may also be interested.

Requirements/Evaluation: May include problem sets, exams, participation, term paper

Prerequisites: MATH 150 or equivalent, ECON 251, or permission of instructor

Enrollment Limit: 19

Enrollment Preferences: Senior Economics Majors

Expected Class Size: 12

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: Mathematical modeling and proofs

Spring 2024

LEC Section: 01 Cancelled

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 514(D2) ECON 389(D2)

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

Spring 2024

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

ENVI 100 (S) Introduction to Weather and Climate (QFR)

Cross-listings: GEOS 100

Secondary Cross-listing

How is it that we have such a hard time predicting if it's going to rain next week, but we can be confident in projections of future climate change decades from now? This course will explore how fundamental laws of physics determine why air moves and changes, creating the wind, clouds, precipitation, and extreme events that form our weather. Building off of our understanding of the atmosphere, we'll look at longer time scales to develop an understanding of earth's climate system, global heat and moisture transport, climate change, and the ways that humans can change our planet. We will use weather and climate models to learn how scientists and meteorologists predict future conditions. Labs include benchtop experiments, data analysis projects, and self-scheduled meteorological observations. This course is in the Oceans and Climate group for the Geosciences major.

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

Prerequisites: none

Enrollment Limit: 60

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 60

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 100(D3) GEOS 100(D3)

Quantitative/Formal Reasoning Notes: This course will have regular problem sets which require substantial quantitative reasoning. Labs will require analysis, presentation, and explanation of quantitative data, and exams will require some quantitative problem solving.

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Alice C. Bradley

LAB Section: 02 M 12:30 pm - 2:30 pm Alice C. Bradley

LAB Section: 03 R 12:30 pm - 2:30 pm Alice C. Bradley

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

Unit Notes: satisfies the distribution requirement for the Biology major

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 t-tests, chi-square analysis, and regression.

Fall 2023

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 209 (F) Modern Climate (QFR)

Cross-listings: GEOS 309

Secondary Cross-listing

What will happen to the Earth's climate in the next century? What is contributing to sea level rise? Is Arctic sea ice doomed? In this course we will study the components of the climate system (atmosphere, ocean, cryosphere, biosphere and land surface) and the processes through which they interact. Greenhouse gas emission scenarios will form the basis for investigating how these systems might respond to human activity. This course will explore how heat and mass are moved around the atmosphere and ocean to demonstrate how the geographic patterns of climate change arise. We will also focus on climate feedback effects--like the albedo feedback associated with sea ice and glacier loss--and how these processes can accelerate climate change. In labs we will learn MATLAB to use process and full-scale climate models to investigate the behavior of these systems in response to increasing greenhouse gasses in the atmosphere. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: 4 multi-week lab projects and several short quizzes

Prerequisites: Any of GEOS 100, GEOS 103, ENVI 102, GEOS 215, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: GEOS and ENVI 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 209(D3) GEOS 309(D3)

Quantitative/Formal Reasoning Notes: Lab projects consist of a series of numerical climate modeling projects, which require significant quantitative and logical reasoning.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Alice C. Bradley

LAB Section: 02 TBA Alice C. Bradley

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

Cross-listings: ECON 213

Secondary Cross-listing

We'll use economics to examine why we harm the environment and overuse natural resources, and what we can do about it. We'll study cost benefit

analysis, pollution in general, climate change, 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 involved in 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)

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

Spring 2024

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

GEOS 100 (S) Introduction to Weather and Climate (QFR)

Cross-listings: ENVI 100

Primary Cross-listing

How is it that we have such a hard time predicting if it's going to rain next week, but we can be confident in projections of future climate change decades from now? This course will explore how fundamental laws of physics determine why air moves and changes, creating the wind, clouds, precipitation, and extreme events that form our weather. Building off of our understanding of the atmosphere, we'll look at longer time scales to develop an understanding of earth's climate system, global heat and moisture transport, climate change, and the ways that humans can change our planet. We will use weather and climate models to learn how scientists and meteorologists predict future conditions. Labs include benchtop experiments, data analysis projects, and self-scheduled meteorological observations. This course is in the Oceans and Climate group for the Geosciences major.

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

Prerequisites: none

Enrollment Limit: 60

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 60

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 100(D3) GEOS 100(D3)

Quantitative/Formal Reasoning Notes: This course will have regular problem sets which require substantial quantitative reasoning. Labs will require analysis, presentation, and explanation of quantitative data, and exams will require some quantitative problem solving.

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Alice C. Bradley

LAB Section: 02 M 12:30 pm - 2:30 pm Alice C. Bradley

LAB Section: 03 R 12:30 pm - 2:30 pm Alice C. Bradley

GEOS 309 (F) Modern Climate (QFR)

Cross-listings: ENVI 209

Primary Cross-listing

What will happen to the Earth's climate in the next century? What is contributing to sea level rise? Is Arctic sea ice doomed? In this course we will study the components of the climate system (atmosphere, ocean, cryosphere, biosphere and land surface) and the processes through which they interact. Greenhouse gas emission scenarios will form the basis for investigating how these systems might respond to human activity. This course will explore how heat and mass are moved around the atmosphere and ocean to demonstrate how the geographic patterns of climate change arise. We will also focus on climate feedback effects--like the albedo feedback associated with sea ice and glacier loss--and how these processes can accelerate climate change. In labs we will learn MATLAB to use process and full-scale climate models to investigate the behavior of these systems in response to increasing greenhouse gasses in the atmosphere. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: 4 multi-week lab projects and several short quizzes

Prerequisites: Any of GEOS 100, GEOS 103, ENVI 102, GEOS 215, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: GEOS and ENVI 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 209(D3) GEOS 309(D3)

Quantitative/Formal Reasoning Notes: Lab projects consist of a series of numerical climate modeling projects, which require significant quantitative and logical reasoning.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Alice C. Bradley

LAB Section: 02 TBA Alice C. Bradley

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 2023

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 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Lori A. Pedersen

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 2023

LEC Section: 01 MWF 8:00 am - 8:50 am Bhagya Athukorallage

LEC Section: 02 MWF 9:00 am - 9:50 am Bhagya Athukorallage

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Lori A. Pedersen

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

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Stewart D. Johnson

LEC Section: 02 MWF 11:00 am - 11:50 am Stewart D. Johnson

LEC Section: 03 MWF 12:00 pm - 12:50 pm Stewart D. Johnson

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Mihai Stoiciu

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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Colin C. Adams

LEC Section: 02 MWF 10:00 am - 10:50 am Colin C. Adams

LEC Section: 03 MWF 11:00 am - 11:50 am Colin C. Adams

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.

Requirements/Evaluation: Fall: Homework, proof portfolio, group work, presentations, quizzes/exams, reflections. Spring: The grade will be based on homework and 4 exams.

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, and other fields of discrete mathematics.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Daniel Condon

LEC Section: 02 TR 11:20 am - 12:35 pm Daniel Condon

Spring 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

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:

MATH 210(D3) PHYS 210(D3)

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

Spring 2024

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.

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Cesar E. Silva

LEC Section: 02 MWF 11:00 am - 11:50 am Cesar E. Silva

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Palak Arora

LEC Section: 02 MWF 10:00 am - 10:50 am Palak Arora

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 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Julie C. Blackwood

Spring 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Bhagya Athukorallage

MATH 314 (F) Cryptography (QFR)

We will discuss some classical ciphers, current asymmetric cryptosystems (DES, AES, Rijndael), public key cryptosystems (RSA, Diffie-Hellman key exchange, ElGamal), and Error Correcting Codes. We will devote a substantial part of the semester covering the necessary mathematical background from number theory and asymptotic analysis. Time permitting, we may also discuss some special topics, such as primality testing (including the polynomial-time AKS algorithm), quantum computers, hash functions, digital signatures, zero-knowledge proofs, information theory, and elliptic curve cryptography.

Requirements/Evaluation: exams, problem sets, quizzes

Prerequisites: MATH 250 or permission of instructor.

Enrollment Limit: 30

Enrollment Preferences: Juniors and seniors.

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will contain mathematical proofs.

Fall 2023

LEC Section: 01 TF 2:35 pm - 3:50 pm Leo Goldmakher

MATH 321 (S) Knot Theory (QFR)

Take a piece of string, tie a knot in it, and glue the ends together. The result is a knotted circle, known as a knot. For the last 100 years, mathematicians have studied knots, asking such questions as, "Given a nasty tangled knot, how do you tell if it can be untangled without cutting it open?" Some of the most interesting advances in knot theory have occurred in the last ten years. This course is an introduction to the theory of knots. Among other topics, we will cover methods of knot tabulation, surfaces applied to knots, polynomials associated to knots, and relationships between

knot theory and chemistry and physics. In addition to learning the theory, we will look at open problems in the field.

Requirements/Evaluation: problem sets, midterms, a paper and a final exam

Prerequisites: MATH 250 or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: seniors, junior, sophomores, first year

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a quantitative course.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Colin C. Adams

MATH 328 (S) Combinatorics (QFR)

Combinatorics is a branch of mathematics that focuses on enumerating, examining, and investigating the existence of discrete mathematical structures with certain properties. This course provides an introduction to the fundamental structures and techniques in combinatorics including enumerative methods, generating functions, partition theory, the principle of inclusion and exclusion, and partially ordered sets.

Class Format: interactive activities and discussion

Requirements/Evaluation: quizzes/exams, homework, activities

Prerequisites: "MATH 250, and MATH 200 or permission of instructor"

Enrollment Limit: 30

Enrollment Preferences: discretion of the instructor

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an upper level course in mathematics

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Daniel Condon

MATH 332 (F) Topics in Applied Linear Algebra (QFR)

This course focuses on applications of Linear Algebra. We will start with a review of the material covered in Math 250, then move on to more advanced topics and applications. We will cover Singular Value Decomposition (SVD), QR factorization, Cholesky factorization, Least Squares problems, the Taylor approximation, the Regression model, Clustering techniques, as well as Linear Dynamical Systems and some of their applications.

Requirements/Evaluation: Homework assignments and exams.

Prerequisites: Math 250

Enrollment Limit: 30

Enrollment Preferences: Mathematics Majors, Seniors

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 course, building upon the core course Math 250 - Linear Algebra.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Palak Arora

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:**

MATH 341(D3) STAT 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

MATH 349 (F) Operations of Order (WS) (QFR)

One of the greatest challenges in mathematics is justifying interchanging orders of operations. Most of the time you cannot switch orders. Frequently this is obvious: the square root of a sum is typically not the sum of the square roots; however, there are many important situations where orders can be reversed. The purpose of this class is to highlight some of the difficulties and dangers in such attempts. This will be a writing intensive course, where we work on content for a book that collects counter-examples and theorems in one convenient place while also showcasing the utility of switching orders. We will discuss at great lengths how to do engaging, technical writing, keeping in mind the content and the audience. Students will receive feedback from the professor and probably other professional mathematicians and editors.

Requirements/Evaluation: Mix of homework, exams, and writing, including at least one chapter (consisting of theory, examples, images, homework problem creation and solutions).**Prerequisites:** Math 250 or permission of the instructor.**Enrollment Limit:** 19**Enrollment Preferences:** If over-enrolled, students will be chosen uniformly at random.**Expected Class Size:** 10**Grading:** yes pass/fail option, yes fifth course option**Distributions:** (D3) (WS) (QFR)**Writing Skills Notes:** Students will be working closely with me and colleagues, receiving feedback on their writing from numerous sources (myself, editors, experts in the field), and their work will be part of the final, published manuscript. We will have numerous discussions about how to write, taking into account the audience and the content.**Quantitative/Formal Reasoning Notes:** This is a 300 level math course.

Fall 2023

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

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, oral exams, and possibly a take-home exam and/or an expository essay.

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: It's math.

Fall 2023

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

Spring 2024

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

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 2024

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

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 2023

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

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Steven J. Miller

LEC Section: 02 TR 9:55 am - 11:10 am Steven J. Miller

MATH 361 (S) 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.

Class Format: Students should sign up for lecture and one conference section.

Requirements/Evaluation: online multiple choice and short answer questions, weekly problem sets in groups, a research project, and a final examination

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

Enrollment Limit: 60; 12/con

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 60

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.

Spring 2024

LEC Section: 01 MR 2:35 pm - 3:50 pm Aaron M. Williams

CON Section: 02 W 11:00 am - 12:00 pm Aaron M. Williams

CON Section: 03 W 12:00 pm - 1:00 pm Aaron M. Williams

CON Section: 04 W 1:00 pm - 2:00 pm Aaron M. Williams

CON Section: 05 W 2:00 pm - 3:00 pm Aaron M. Williams

CON Section: 06 W 3:00 pm - 4:00 pm Aaron M. Williams

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 gleaming 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 2024

TUT Section: T1 TBA Leo Goldmakher

MATH 383 (F) Complex Analysis (QFR)

The calculus of complex-valued functions turns out to have unexpected simplicity and power. As an example of simplicity, every complex-differentiable function is automatically infinitely differentiable. As examples of power, the so-called "residue calculus" permits the computation of "impossible" integrals, and "conformal mapping" reduces physical problems on very general domains to problems on the round disc. The easiest proof of the Fundamental Theorem of Algebra, not to mention the first proof of the Prime Number Theorem, used complex analysis.

Requirements/Evaluation: homework, classwork, and exams

Prerequisites: MATH 350 or MATH 351 or permission of instructor

Enrollment Limit: 40

Enrollment Preferences: 40

Expected Class Size: 30

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

Unit Notes: this course is not a senior seminar, so it does not fulfill the senior seminar requirement for the Math major

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Advanced mathematics course with weekly or daily problem sets.

Fall 2023

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

MATH 394 (S) Galois Theory (QFR)

Some equations--such as $x^5-1=0$ --are easy to solve. Others--such as $x^5-x-1=0$ --are very hard, if not impossible (using finite combinations of standard mathematical operations). Galois discovered a deep connection between field theory and group theory that led to a criterion for checking whether or not a given polynomial can be easily solved. His discovery also led to many other breakthroughs, for example proving the impossibility of squaring the circle or trisecting a typical angle using compass and straightedge. From these not-so-humble beginnings, Galois theory has become a fundamental concept in modern mathematics, from topology to number theory. In this course we will develop the theory and explore its applications to other areas of math.

Requirements/Evaluation: problem sets and oral exams

Prerequisites: MATH 355

Enrollment Limit: 30

Enrollment Preferences: Juniors and seniors

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a math class

Spring 2024

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

MATH 407 (F) Dance of the Primes (QFR)

Prime numbers are the building blocks for all numbers and hence for most of mathematics. Though there are an infinite number of them, how they are spread out among the integers is still quite a mystery. Even more mysterious and surprising is that the current tools for investigating prime numbers involve the study of infinite series. Function theory tells us about the primes. We will be studying one of the most amazing functions known: the Riemann Zeta Function. Finding where this function is equal to zero is the Riemann Hypothesis and is one of the great, if not greatest, open problems in mathematics. Somehow where these zeros occur is linked to the distribution of primes. We will be concerned with why anyone would care about this conjecture. More crassly, why should solving the Riemann Hypothesis be worth one million dollars? (Which is what you will get if you solve it, beyond the eternal fame and glory.)

Requirements/Evaluation: exams and weekly homework assignments

Prerequisites: MATH 350 or MATH 351, and MATH 355

Enrollment Limit: 30

Enrollment Preferences: seniors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is a math course.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

MATH 415 (F) Advanced Matrix Analysis (QFR)

This course will start with a review of various attributes of matrices (determinants, rank, etc), as well as eigenvalues, eigenvectors, and their properties. Then we will move on to study special matrices and their decompositions, along with similarities, and Jordan canonical forms. In the third segment, we will define norms on vectors and matrices and study their analytic properties. Finally, we will discuss another important class of matrices - positive definite and semidefinite matrices. If time permits, we will also cover positive and negative matrices and their properties.

Requirements/Evaluation: Homework assignments and exams.

Prerequisites: Math 350/351 or permission of instructor

Enrollment Limit: 25

Enrollment Preferences: Mathematics and Statistics Majors, Seniors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced mathematics class that covers complex properties of matrices and some of their applications.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Palak Arora

MATH 419 (F) Algebraic Number Theory (QFR)

We all know that integers can be factored into prime numbers and that this factorization is essentially unique. In more general settings, it often still makes sense to factor numbers into "primes," but the factorization is not necessarily unique! This surprising fact was the downfall of Lamé's attempted proof of Fermat's Last Theorem in 1847. Although a valid proof was not discovered until over 150 years later, this error gave rise to a new branch of mathematics: algebraic number theory. In this course, we will study factorization and other number-theoretic notions in more abstract algebraic settings, and we will see a beautiful interplay between groups, rings, and fields.

Requirements/Evaluation: homework assignments and exams

Prerequisites: MATH 355, or permission of instructor

Enrollment Limit: 25

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Fall 2023

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

MATH 434 (S) Applied Dynamics and Optimal Control (QFR)

We seek to understand how dynamical systems evolve, how that evolution depends on the various parameters of the system, and how we might manipulate those parameters to optimize an overall outcome. The primary focus of this course will be optimal control using Pontryagin's maximum principle and Hamilton-Jacobi-Bellman equations. These tools have broad application in ecology, economics, finance, and engineering, and we will draw on basic models from these fields to motivate our study. The course will begin with a solid review of modeling with dynamical systems, and deepening our understanding of differential and difference equations, parameter dependence, and bifurcations.

Requirements/Evaluation: exams, homework assignments, and projects

Prerequisites: MATH 309 or PHYS 210, and MATH 350 or 351, or permission of the instructor

Enrollment Limit: 25

Enrollment Preferences: Preference will be given to senior math majors.

Expected Class Size: 20

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

Distributions: (D3) (QFR)

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

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Stewart D. Johnson

MATH 445 (S) Topics in Numerical Analysis (QFR)

Numerical analysis is a field of mathematics that focuses on developing algorithms and computational methods to solve problems that cannot be solved exactly. In this senior seminar course on numerical analysis we will cover advanced topics such as numerical solutions of Partial Differential Equations, Random Numbers and Monte Carlo simulation, Fast Fourier Transform and signal processing, as well as applications of the Singular Value Decomposition for matrices. The course will start with a review of basic concepts from calculus, linear algebra, and differential equations. Students who have taken Introduction to Numerical Analysis (Math 345) are welcome to take this course.

Requirements/Evaluation: exams and homework assignments

Prerequisites: Math 309 or Math 345 or permission of instructor

Enrollment Limit: 25

Enrollment Preferences: Mathematics Majors, Seniors

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a senior seminar course in mathematics.

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Bhagya Athukorallage

MATH 457 (S) Partition Theory (QFR)

The partitions of a positive integer are the different ways of writing it as a sum of positive integers. For example, 5 has seven partitions, three of which are $5=1+1+1+1+1$, $5=2+3$, and $5=5$. (Can you find the rest?) Partition theory is a rich area of combinatorics with applications to algebra and mathematical physics. In this class we will focus on enumerative and bijective methods to answer questions such as: How can we calculate the number of partitions of a number efficiently? Why is the number of partitions of N into strictly odd numbers always the same as the number of its partitions into distinct numbers? Why does a 2-dimensional partition look like a stack of cubes, and what does that have to do with tilings?

Requirements/Evaluation: Written homework; Written/Oral Exams; Project/Presentation

Prerequisites: A course in abstract algebra such as MATH 355, or permission of instructor.

Enrollment Limit: 25

Enrollment Preferences: Priority given to Junior and Seniors, and according to previous experience with subject.

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced course in mathematics.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Daniel Condon

PHIL 203 (F) Logic and Language (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. We will examine the virtues and vices of good arguments in both informal and formal systems. The goals of this course are to improve the critical thinking of the students, to introduce them to sentential and predicate logic, to familiarize them with enough formal logic to enable them to read some of the great works of philosophy that use formal logic (such as Wittgenstein's *Tractatus*), and to examine some of the connections between logic and philosophy.

Class Format: discussion

Requirements/Evaluation: a midterm, a final, frequent homework and problem sets

Prerequisites: none

Enrollment Limit: 40/sect

Enrollment Preferences: Philosophy majors, seniors, juniors, sophomores, first-years in that order.

Expected Class Size: 40/sect

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: The main part of the course is learning two formal languages of logic: sentential logic and predicate logic

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Steven B. Gerrard

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:

COGS 224(D2) PHIL 221(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).

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Christian De Leon

PHIL 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHYS 312 / STS 312

Secondary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and Physics 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:

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland

PHYS 109 (S) Sound, Light, and Perception (QFR)

Light and sound allow us to perceive the world around us, from appreciating music and art to learning the details of atomic structure. Because of their importance in human experience, light and sound have long been the subject of scientific inquiry. How are sound and light related? How do physiology and neural processing allow us to hear and see the world around us? What are the origins of color and musical pitch? This course introduces the science and technology of light and sound to students not majoring in physics. We will start with the origins of sound and light as wave phenomena, and go on to topics including color, the optics of vision, the meaning of musical pitch and tone, and the physical basis of hearing. We will also discuss some recent technological applications of light, such as lasers and optical communications. The class will meet for two 75-minute periods each week for a variable mixture of lecture, discussion, and hands-on, interactive experiments.

Class Format: The two weekly class sections will be located in a space suitable for both lecture and hands-on laboratory-style work

Requirements/Evaluation: class participation, problem sets, in-class midterm, oral presentations, and a final exam, all with a quantitative component

Prerequisites: none

Enrollment Limit: 20

Enrollment Preferences: non-science majors

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This class will have frequent problem sets requiring substantial quantitative reasoning

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Catherine Kealhofer

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: 30

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 2023

LEC Section: 01 MWF 11:00 am - 11:50 am John H. Lacy

LAB Section: 02 M 1:00 pm - 4:00 pm Brough Morris

LAB Section: 03 T 1:00 pm - 4:00 pm Brough Morris

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 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Protik K. Majumder

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 2023

LEC Section: 01 MWF 11:00 am - 11:50 am Katharine E. Jensen

LAB Section: 02 M 1:00 pm - 4:00 pm Katharine E. Jensen

LAB Section: 03 T 1:00 pm - 4:00 pm Katharine E. Jensen

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

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 2024

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 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Daniel P. Aalberts

LAB Section: 02 W 1:10 pm - 3:50 pm Daniel P. Aalberts

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 take-home 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 2023

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 209 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 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Charlie Doret

LAB Section: 02 T 1:00 pm - 4:00 pm Charlie Doret

LAB Section: 03 W 1:00 pm - 4:00 pm Charlie Doret

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:

MATH 210(D3) PHYS 210(D3)

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

Spring 2024

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

PHYS 301 (F) Quantum Physics (QFR)

This course serves as a one-semester introduction to the formalism, and phenomenology of quantum mechanics. After a brief discussion of historical origins of the quantum theory, we introduce 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: 20

Enrollment Preferences: physics majors

Expected Class Size: 15

Grading: no pass/fail option, yes 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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Protik K. Majumder

LAB Section: 02 M 1:00 pm - 4:00 pm John H. Lacy

LAB Section: 03 T 1:00 pm - 4:00 pm John H. Lacy

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, midterm exam, final exam, and labs, 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: 20

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

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Katharine E. Jensen

LAB Section: 02 W 1:00 pm - 4:00 pm Katharine E. Jensen

LAB Section: 03 R 1:00 pm - 4:00 pm Katharine E. Jensen

PHYS 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHIL 312 / STS 312

Primary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and 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:

PHIL 312(D2) PHYS 312(D3) STS 312(D2)

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland

PHYS 314 (S) Controlling Quanta (QFR)

This course will explore modern developments in the control of individual quantum systems. Topics covered will include basic physical theories of atoms coupled to photons, underlying mathematical tools (including Lie algebras and groups), and computational methods to simulate and analyze quantum systems. Applications to quantum computing, teleportation, and experimental metaphysics (Bell's inequality) will also be discussed.

Requirements/Evaluation: tutorial preparation and participation, weekly problem sets/papers, and a final project

Prerequisites: PHYS/MATH 210 or MATH 209 or MATH 250

Enrollment Limit: 10

Enrollment Preferences: sophomores and junior Physics majors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course involves weekly problems sets involving linear algebra, calculus, and other mathematical methods.

Spring 2024

TUT Section: T1 F 1:10 pm - 2:25 pm Frederick W. Strauch

PHYS 405 (F) Electromagnetic Theory (QFR)

This course builds on the material of Physics 201, and explores the application of Maxwell's Equations to understand a range of topics including electric fields and matter, magnetic materials, light, and radiation. As we explore diverse phenomena, we will learn useful approximation techniques and beautiful mathematical tools. In addition to weekly tutorial meetings, the class will meet once a week as a whole to introduce new material.

Class Format: Class will meet once as a whole to introduce new material and for informal discussion.

Requirements/Evaluation: weekly problem sets, tutorial participation, presentations, and a final exam or final project, all of which have a substantial quantitative component

Prerequisites: PHYS 202 and PHYS/MATH 210 or MATH 209 or MATH 309

Enrollment Limit: 30

Enrollment Preferences: Preference will be given to physics and astrophysics majors.

Expected Class Size: 18

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Physics courses are all heavily dependent on QFR skills. Phys 405 will feature extensive use of vector calculus and differential equations while also asking students to develop facility with approximation techniques in solving complex problems throughout the semester.

Fall 2023

TUT Section: T1 F 1:10 pm - 2:25 pm Charlie Doret

PHYS 418 (S) Gravity (QFR)

This course is an introduction Einstein's theory of general relativity. We begin with a review of special relativity, emphasizing geometrical aspects of Minkowski spacetime. Working from the equivalence principle, we then motivate gravity as spacetime curvature, and study in detail the Schwarzschild geometry around a spherically symmetric mass. After this application, we use tensors to develop Einstein's equation, which describes how energy density curves spacetime. With this equation in hand we study the Friedmann-Robertson-Walker geometries for an expanding universe, and finally, we linearize Einstein's equation to develop the theory of gravitational waves.

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

Prerequisites: PHYS 301 or PHYS 405 or PHYS 411, or permission of instructor

Enrollment Limit: none

Enrollment Preferences: none

Expected Class Size: 10

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

Distributions: (D3) (QFR)

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

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm David R. Tucker-Smith

POEC 253 (F) Empirical Methods in Political Economy (QFR)

This course introduces students to common empirical tools used in policy analysis and implementation. The broad aim is to train students to be discriminating consumers of public policy-relevant research. The emphasis in the course is on intuitive understanding of the central concepts. 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; random variables and distributions; statistical estimation, inference and hypothesis testing; and modeling using multiple regression, with a particular focus on understanding whether and how relationships between variables can be determined to be causal--an essential requirement for effective policy formation. 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) (QFR)

Quantitative/Formal Reasoning Notes: The course teaches econometrics, i.e. statistics as economists use it, with applications in economics, political science, and other fields.

Fall 2023

LEC Section: 01 TF 2:35 pm - 3:50 pm Anand V. Swamy

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.

Fall 2023

LEC Section: A1 TR 11:20 am - 12:35 pm Steven Fein

LAB Section: A2 W 1:00 pm - 4:00 pm Steven Fein

LEC Section: B3 TR 8:30 am - 9:45 am Noah J. Sandstrom

LAB Section: B4 R 1:00 pm - 4:00 pm Noah J. Sandstrom

Spring 2024

LEC Section: A1 TR 11:20 am - 12:35 pm Steven Fein

LAB Section: A2 W 1:00 pm - 4:00 pm Steven Fein

LEC Section: B3 TR 11:20 am - 12:35 pm Kris N. Kirby

LAB Section: B4 W 1:00 pm - 4:00 pm Kris N. Kirby

LEC Section: C5 MR 1:10 pm - 2:25 pm Catherine B. Stroud

LAB Section: C6 T 1:00 pm - 4:00 pm Catherine B. Stroud

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.

Fall 2023

LEC Section: 01 MWF 8:30 am - 9:45 am Bernhard Klingenberg

Spring 2024

LEC Section: 01 TF 1:10 pm - 2:25 pm Xizhen Cai

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

Fall 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Norean R. Sharpe

LEC Section: 02 MWF 10:00 am - 10:50 am Norean R. Sharpe

Spring 2024

LEC Section: 01 MW 8:30 am - 9:45 am Norean R. Sharpe

LEC Section: 02 MW 11:00 am - 12:15 pm Norean R. Sharpe

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.

Fall 2023

LEC Section: 01 MWF 11:00 am - 11:50 am Anna M. Plantinga

Spring 2024

LEC Section: 01 MWF 11:00 am - 12:15 pm Anna M. Plantinga

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.

Fall 2023

LEC Section: 01 TR 8:30 am - 9:45 am Shaoyang Ning

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

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Shaoyang Ning

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.

Spring 2024

LEC Section: 01 MWF 8:30 am - 9:45 am 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:

MATH 341(D3) STAT 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

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, theory and data analysis exams, 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 2023

LEC Section: 01 MWF 8:30 am - 9:45 am Anna M. Plantinga

Spring 2024

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 is necessary to analyze and describe such datasets with more than multiple variables. Topics covered will include data visualization techniques for high dimensional data sets, parametric and non-parametric techniques to estimate joint distributions, techniques for combining variables and making inferences, and several classification and clustering algorithms.

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 2023

LEC Section: 01 TR 9:55 am - 11:10 am 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 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Bernhard Klingenberg

STAT 365 (S) Bayesian Statistics (QFR)

The Bayesian approach to statistical inference represents a reversal of traditional (or frequentist) inference, in which data are viewed as being fixed and model parameters as unknown quantities. Interest and application of Bayesian methods have exploded in recent decades, being facilitated by recent advances in computational power. We begin with an introduction to Bayes' Theorem, the theoretical underpinning of Bayesian statistics which dates back to the 1700's, and the concepts of prior and posterior distributions, conjugacy, and closed-form Bayesian inference. Building on this, we introduce modern computational approaches to Bayesian inference, including Markov chain Monte Carlo (MCMC), Metropolis-Hastings sampling, and the theory underlying these simple and powerful methods. Students will become comfortable with modern software tools for MCMC using a variety of applied hierarchical modeling examples, and will use R for all statistical computing.

Requirements/Evaluation: weekly homework and exams

Prerequisites: MATH/STAT 341 and STAT 346, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: juniors and seniors, Statistics majors, students who have taken STAT 360

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course utilizes mathematics and computer-based tools for the Bayesian approach for analyzing data and making statistical inferences.

Spring 2024

LEC Section: 01 Cancelled

STAT 440 (S) Categorical Data Analysis (QFR)

This course focuses on methods for analyzing categorical response data. Traditional tools of statistical data analysis for continuous response data are not designed to handle such data and pose inappropriate assumptions. We will develop methods specifically designed to address the discrete nature of the observations and consider many applications in the social and biological sciences as well as in medicine, engineering and economics. The first part of the course will discuss statistical inference for parameters of categorical distributions and arising in contingency tables. The longer second part will focus on statistical modeling via generalized linear models for binary, multinomial, ordinal and count response variables, using maximum likelihood.

Requirements/Evaluation: Class participation and performance on exams, homework, and a project.

Prerequisites: STAT 346 and STAT 360

Enrollment Limit: 15

Enrollment Preferences: seniors and statistics majors

Expected Class Size: 12

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Arguing with data.

Spring 2024

LEC Section: 01 Cancelled

STAT 442 (F) 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.

Fall 2023

LEC Section: 01 TF 1:10 pm - 2:25 pm Shaoyang Ning

STAT 465 (S) Bayesian Statistics (QFR)

Prior knowledge being constantly updated by empirical observations -- the essence of Bayesian thinking provides a natural, intuitive, and more importantly, mathematically sounded, probabilistically principled way to characterize the process of learning. With some of its key ideas formulated based on Bayes' Theorem dating back to 18th century, Bayesian inference is one of oldest schools of statistics (more than a century earlier than the Frequentist!). Yet it was not until the recent developments in sampling algorithms and computational powers that Bayesian inference gained its revival. Bayesian, and Bayesian-based methods, with their flexibilities in modeling (generative) process of data, interpretability with posterior probability statements, and coherent principles to incorporate empirical evidence a priori, have played key roles in modern data analysis, especially for those "big data" with enhanced complexity and connectivity. This course is designed to provide students a comprehensive understanding to what is Bayesian and the how's and why's. Students will be introduced to classic Bayesian models, basic computational algorithms/methods for Bayesian inference, as well as their applications in various fields, and comparisons with classic Frequentist methods. As Bayesian inference finds its roots and merits particularly

in application, this course puts great emphasis on enhancing students' skills in statistical computation (mostly with R) and data analysis.

Requirements/Evaluation: Homework, exams, and project

Prerequisites: MATH/STAT 341, STAT 346, and STAT 360, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: seniors, Statistics majors

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course utilizes mathematics and computer-based tools for the Bayesian approach for analyzing data and making statistical inferences.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Shaoyang Ning

STS 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHIL 312 / PHYS 312

Secondary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and Physics 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 312(D2) PHYS 312(D3) STS 312(D2)

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland

Quantitative and Formal Reasoning

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 6 afternoon labs. 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

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 2023

LAB Section: 02 M 1:10 pm - 4:00 pm Kevin Flaherty

LAB Section: 03 R 1:10 pm - 4:00 pm Kevin Flaherty

LEC Section: 01 TR 11:20 am - 12:35 pm Marek Demianski

ASTR 211 (S) Astronomical Observing and Data Analysis (QFR)

How do astronomers make scientific measurements for objects that are light-years away from Earth? This course will introduce the basics of telescopes and observations and will give students hands-on training in the techniques astronomers use to obtain, process, and analyze scientific data. We will discuss observation planning, CCD detectors, signal statistics, image processing, and photometric and spectroscopic observations. We will begin by focusing on ground-based optical observations and will move on to non-optical observations, both electromagnetic (e.g., radio waves, X-rays) and non-electromagnetic (e.g., gravitational waves, neutrinos). Throughout the course, students will use computational techniques to work with real astronomical data, taken with our 24" telescope and from data archives.

Class Format: discussion, computer lab work, and observing

Requirements/Evaluation: weekly problem sets, lab work, and observing projects

Prerequisites: MATH 150 or 151; prior experience with Unix and computer programming is helpful, but not required

Enrollment Limit: 14

Enrollment Preferences: Astronomy or Astrophysics majors

Expected Class Size: 8

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course requires regular problem sets. Labs require computer programming and statistical and graphical analyses of data.

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Anne Jaskot

LAB Section: 02 W 1:10 pm - 3:50 pm Kevin Flaherty

ASTR 402 (F) 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.

Fall 2023

TUT Section: T1 TBA Anne Jaskot

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 2024

IND Section: 01 TBA Protik K. Majumder

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

Cross-listings: CHEM 321 / BIOL 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: 16/lab

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:

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

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

Fall 2023

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

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:

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

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

Spring 2024

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

LEC Section: 01 TR 11:20 am - 12:35 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.

Fall 2023

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

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

LEC Section: 01 MWF 11:00 am - 11:50 am David W. Loehlin

LAB Section: 05 M 1:00 pm - 3:50 pm Derek Dean

LAB Section: 04 R 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

Unit Notes: satisfies the distribution requirement for the Biology major

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 t-tests, chi-square analysis, and regression.

Fall 2023

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

LAB Section: 03 W 1:00 pm - 3:50 pm Manuel A. Morales

BIOL 305 (F) 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.

Fall 2023

LAB Section: 02 T 1:00 pm - 3:50 pm Luana S. Maroja

LAB Section: 03 W 1:00 pm - 3:50 pm Luana S. Maroja

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

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

Cross-listings: CHEM 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: 16/lab

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:

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

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

Fall 2023

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

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

Cross-listings: CHEM 322 / BIMO 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:

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

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

Spring 2024

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

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

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 2023

LEC Section: 02 MWF 10:00 am - 10:50 am Katie M. Hart

LAB Section: 03 T 1:00 pm - 4:00 pm Katie M. Hart

LAB Section: 04 W 1:00 pm - 4:00 pm Sarah L. Goh

LEC Section: 01 MWF 9:00 am - 9:50 am Sarah L. Goh

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, ethics, 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).

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.

Fall 2023

LAB Section: 08 Cancelled

LAB Section: 06 R 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 05 W 1:00 pm - 5:00 pm Stephanie Christau

LAB Section: 04 T 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 09 W 1:00 pm - 5:00 pm Ben L. Augenbraun

LAB Section: 03 M 1:00 pm - 5:00 pm Bob Rawle

LEC Section: 01 MWF 10:00 am - 10:50 am Bob Rawle

LEC Section: 02 MWF 11:00 am - 11:50 am Ben L. Augenbraun

LAB Section: 07 M 1:00 pm - 5:00 pm Laura R. Strauch

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Sarah L. Goh, Amy Gehring

LAB Section: 06 R 1:00 pm - 5:00 pm B Thuronyi

LAB Section: 04 T 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 05 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 03 M 1:00 pm - 5:00 pm Sarah L. Goh

LEC Section: 02 MWF 10:00 am - 10:50 am Amy Gehring, Sarah L. Goh

CHEM 200 (S) Advanced Chemical Concepts (QFR)

Class of 2027 ONLY (Class of 2024, 2025, 2026 see CHEM 256). 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: 45; 16/lab

Enrollment Preferences: first-year students, then sophomores

Expected Class Size: 45/lecture

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.

Spring 2024

LAB Section: 05 W 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 04 T 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 03 M 1:00 pm - 5:00 pm Laura R. Strauch

LAB Section: 07 T 8:00 am - 12:00 pm Laura R. Strauch

LAB Section: 06 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LEC Section: 02 MWF 10:00 am - 10:50 am Enrique Peacock-López

LEC Section: 01 MWF 9:00 am - 9:50 am Enrique Peacock-López

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: 16/lab

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:

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

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

Fall 2023

LAB Section: 03 W 1:00 pm - 5:00 pm Jenna L. MacIntire

LAB Section: 04 R 1:00 pm - 5:00 pm Jenna L. MacIntire

LEC Section: 01 MWF 10:00 am - 10:50 am B Thuronyi

LAB Section: 02 T 1:00 pm - 5:00 pm B Thuronyi

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

Cross-listings: BIOL 322 / BIMO 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:

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

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

Spring 2024

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

LAB Section: 04 R 1:00 pm - 3:50 pm Janis E. Bravo

LAB Section: 02 T 1:00 pm - 3:50 pm Janis E. Bravo

CHEM 368 (S) Computational Chemistry and Molecular Spectroscopy (QFR)

This tutorial provides an introduction to the principles of computational quantum mechanics and their application to problems of chemical interest such as chemical bonding, chemical reactivity, and molecular spectroscopy. Emphasis is placed upon modern electronic structure calculations, their fundamentals, practical considerations, interpretation, and applications to current research questions. Under guidance in sessions and through independent work, students will use computational methods to explore assigned weekly research problems. The research results will be presented to and discussed with the tutorial partner at the end of each week.

Requirements/Evaluation: tutorial participation, presentations, and submitted papers

Prerequisites: CHEM 361 or equivalent background in Physics

Enrollment Limit: 10

Enrollment Preferences: Chemistry majors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

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

Spring 2024

TUT Section: T1 Cancelled

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:

COGS 224(D2) PHIL 221(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).

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 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 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Stephen N. Freund

LAB Section: 04 M 2:30 pm - 4:00 pm Stephen N. Freund

LAB Section: 03 M 1:00 pm - 2:30 pm Stephen N. Freund

LEC Section: 02 MWF 11:00 am - 11:50 am Katie A. Keith

LAB Section: 05 T 1:00 pm - 2:30 pm Katie A. Keith

LAB Section: 06 T 2:30 pm - 4:00 pm Katie A. Keith

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.

Fall 2023

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

LAB Section: 05 M 1:00 pm - 2:30 pm Mark Hopkins

LAB Section: 04 M 1:00 pm - 2:30 pm Iris Howley

LAB Section: 09 T 2:30 pm - 4:00 pm Iris Howley

LAB Section: 08 T 1:00 pm - 2:30 pm Mark Hopkins

LAB Section: 07 T 1:00 pm - 2:30 pm Iris Howley

LEC Section: 03 MWF 11:00 am - 11:50 am Iris Howley

LEC Section: 02 MWF 10:00 am - 10:50 am Iris Howley

LAB Section: 06 M 2:30 pm - 4:00 pm Iris Howley

Spring 2024

LAB Section: 07 T 1:00 pm - 2:30 pm Shikha Singh

LAB Section: 06 M 2:30 pm - 4:00 pm Shikha Singh

LAB Section: 08 T 2:30 pm - 4:00 pm Bill K. Jannen

LAB Section: 09 T 2:30 pm - 4:00 pm Shikha Singh

LEC Section: 03 MWF 11:00 am - 11:50 am Shikha Singh

LEC Section: 02 MWF 10:00 am - 10:50 am Shikha Singh

LAB Section: 05 M 1:00 pm - 2:30 pm Bill K. Jannen

LAB Section: 04 M 1:00 pm - 2:30 pm Shikha Singh

LEC Section: 01 MWF 9:00 am - 9:50 am Bill K. Jannen

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.

Fall 2023

LAB Section: 05 R 1:00 pm - 2:30 pm James M. Bern

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: 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

Spring 2024

LAB Section: 05 R 1:00 pm - 2:30 pm Katie A. Keith

LAB Section: 04 W 2:30 pm - 4:00 pm Katie A. Keith

LAB Section: 03 W 1:00 pm - 2:30 pm Katie A. Keith

LEC Section: 02 MWF 10:00 am - 10:50 am Katie A. Keith

LEC Section: 01 MWF 9:00 am - 9:50 am 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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Bill K. Jannen

LAB Section: 03 W 1:00 pm - 2:30 pm Bill K. Jannen

LEC Section: 02 MWF 11:00 am - 11:50 am Bill K. Jannen

LAB Section: 06 R 2:30 pm - 4:00 pm Bill K. Jannen

LAB Section: 05 R 1:00 pm - 2:30 pm Bill K. Jannen

LAB Section: 04 W 2:30 pm - 4:00 pm Bill K. Jannen

Spring 2024

LAB Section: 03 R 1:00 pm - 2:30 pm Jeannie R Albrecht

LAB Section: 02 W 1:00 pm - 2:30 pm Jeannie R Albrecht

LEC Section: 01 MWF 12:00 pm - 12:50 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 2023

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

Spring 2024

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 331 (F) Introduction to Computer Security (QFR)

This class explores common vulnerabilities in computer systems, how attackers exploit them, and how systems engineers design defenses to mitigate them. The goal is to be able to recognize potential vulnerabilities in one's own software and to practice defensive design. Hands-on experience writing assembly language and C code to inspect and modify the low-level operation of running programs is emphasized. Finally, regular reading and writing assignments round out the course to help students understand the cultural and historical background of the computer security "arms race."

Class Format: This course has twice-weekly lecture meetings as well as a weekly lab meeting.

Requirements/Evaluation: weekly reading responses, lab assignments, midterm exam, and final project

Prerequisites: CSCI 237

Enrollment Limit: 24(12/lab)

Enrollment Preferences: upper-level students

Expected Class Size: 24

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

Materials/Lab Fee: A fee of \$75-\$100 will be added to the term bill to cover the purchase of a Raspberry Pi computer and accessories.

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.

Fall 2023

LAB Section: 03 T 2:30 pm - 4:00 pm Daniel W. Barowy

LEC Section: 01 MR 2:35 pm - 3:50 pm Daniel W. Barowy

LAB Section: 02 T 1:00 pm - 2:30 pm Daniel W. Barowy

CSCI 334 (F)(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.

Fall 2023

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

Spring 2024

LEC Section: 01 TR 9:55 am - 11:10 am Daniel W. Barowy

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 2024

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

LEC Section: 01 TR 9:55 am - 11:10 am James M. Bern

CSCI 361 (S) 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 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.

Class Format: Students should sign up for lecture and one conference section.

Requirements/Evaluation: online multiple choice and short answer questions, weekly problem sets in groups, a research project, and a final examination

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

Enrollment Limit: 60; 12/con

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 60

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.

Spring 2024

CON Section: 03 W 12:00 pm - 1:00 pm Aaron M. Williams

LEC Section: 01 MR 2:35 pm - 3:50 pm Aaron M. Williams

CON Section: 02 W 11:00 am - 12:00 pm Aaron M. Williams

CON Section: 05 W 2:00 pm - 3:00 pm Aaron M. Williams

CON Section: 04 W 1:00 pm - 2:00 pm Aaron M. Williams

CON Section: 06 W 3:00 pm - 4:00 pm Aaron M. Williams

CSCI 374 (F) Machine Learning (QFR)

Machine learning is a field that derives from artificial intelligence and statistics, and is concerned with the design and analysis of computer algorithms that "learn" automatically through the use of data. Computer algorithms are capable of discerning subtle patterns and structure in the data that would be practically impossible for a human to find. As a result, real-world decisions, such as treatment options and loan approvals, are being increasingly automated based on predictions or factual knowledge derived from such algorithms. This course explores topics in supervised learning (e.g., random

forests and neural networks), unsupervised learning (e.g., k-means clustering and expectation maximization), and possibly reinforcement learning (e.g., Q-learning and temporal difference learning.) It will also introduce methods for the evaluation of learning algorithms (with an emphasis on analysis of generalizability and robustness of the algorithms to distribution/environmental shift), as well as topics in computational learning theory and ethics.

Requirements/Evaluation: Presentations, problem sets, programming exercises, empirical analyses of algorithms, critical analysis of current literature; the final two weeks are focused on a project of the student's design.

Prerequisites: CSCI 136 and CSCI 256 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: This course heavily relies on discrete mathematics, calculus, and elementary statistics. Students will be proving theorems, among many other mathematically oriented assignments. Additionally, they will be programming, which involves analytical and logical thinking.

Fall 2023

LEC Section: 01 MR 1:10 pm - 2:25 pm Rohit Bhattacharya

LEC Section: 02 MR 2:35 pm - 3:50 pm Rohit Bhattacharya

CSCI 379 (S) Causal Inference (QFR)

Does X cause Y? If so, how? And what is the strength of this causal relation? Seeking answers to such causal (as opposed to associational) questions is a fundamental human endeavor; the answers we find can be used to support decision-making in various settings such as healthcare and public policy. But how does one tease apart causation from association--early in our statistical education we are taught that "correlation does not imply causation." In this course, we will re-examine this phrase and learn how to reason with confidence about the validity of causal conclusions drawn from messy real-world data. We will cover core topics in causal inference including causal graphical models, unsupervised learning of the structure of these models, expression of causal quantities as functions of observed data, and robust/efficient estimation of these quantities using statistical and machine learning methods. Concepts in the course will be contextualized via regular case studies.

Requirements/Evaluation: Problem sets, programming exercises, empirical analyses, case studies, and a final project.

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

Enrollment Limit: 24

Enrollment Preferences: Computer science majors and prospective majors.

Expected Class Size: 24

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course heavily relies on discrete mathematics, algorithms, and elementary statistics. There will be regular assignments requiring rigorous quantitative or formal reasoning.

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Rohit Bhattacharya

CSCI 381 (S) 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.

Spring 2024

LEC Section: 02 MWF 12:00 pm - 12:50 pm Mark Hopkins

LEC Section: 01 MWF 11:00 am - 11:50 am Mark Hopkins

CSCI 432 (F) Operating Systems (QFR)

This course explores the design and implementation of computer operating systems. Topics include historical aspects of operating systems development, systems programming, process scheduling, synchronization of concurrent processes, virtual machines, memory management and virtual memory, I/O and file systems, system security, os/architecture interaction, and distributed operating systems.

Requirements/Evaluation: several implementation projects that will include significant programming, as well as written homework, and up to two exams

Prerequisites: CSCI 237 and either CSCI 256 or 334

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/or programming assignments in which quantitative/formal reasoning skills are practiced and evaluated.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Jeannie R Albrecht

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.

Fall 2023

LEC Section: 03 TF 1:10 pm - 2:25 pm Katie Gutierrez

LEC Section: 01 TR 9:55 am - 11:10 am Susan Godlonton

LEC Section: 02 TR 11:20 am - 12:35 pm Owen Thompson

LEC Section: 06 MR 2:35 pm - 3:50 pm Owen Thompson

LEC Section: 04 TF 2:35 pm - 3:50 pm Katie Gutierrez

LEC Section: 05 MR 1:10 pm - 2:25 pm Owen Thompson

Spring 2024

LEC Section: 01 TF 1:10 pm - 2:25 pm Matthew Chao

LEC Section: 02 TF 2:35 pm - 3:50 pm Matthew Chao

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.

Fall 2023

LEC Section: 01 MR 1:10 pm - 2:25 pm Caitlin E. Hegarty

LEC Section: 02 MR 2:35 pm - 3:50 pm Caitlin E. Hegarty

Spring 2024

LEC Section: 01 MR 1:10 pm - 2:25 pm Sara LaLumia

LEC Section: 05 MWF 10:00 am - 10:50 am Neal J. Rappaport

LEC Section: 04 MWF 9:00 am - 9:50 am Neal J. Rappaport

LEC Section: 02 MR 2:35 pm - 3:50 pm Sara LaLumia

LEC Section: 03 TR 8:30 am - 9:45 am Will Olney

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

Cross-listings: ENVI 213

Primary Cross-listing

We'll use economics to examine why we harm the environment and overuse natural resources, and what we can do about it. We'll study cost benefit analysis, pollution in general, climate change, 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 involved in 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)

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

Spring 2024

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

ECON 232 (F) 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.

Fall 2023

LEC Section: 01 TR 8:30 am - 9:45 am Neal J. Rappaport

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 2023

LEC Section: 02 MWF 11:00 am - 12:15 pm Sara LaLumia

LEC Section: 03 TR 11:20 am - 12:35 pm Neal J. Rappaport

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

LEC Section: 04 MR 1:10 pm - 2:25 pm Neal J. Rappaport

Spring 2024

LEC Section: 02 Cancelled

LEC Section: 01 MR 1:10 pm - 2:25 pm Greg Phelan

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 2023

LEC Section: 01 TR 9:55 am - 11:10 am Burak Uras

LEC Section: 02 TR 11:20 am - 12:35 pm Burak Uras

Spring 2024

LEC Section: 02 MWF 11:00 am - 12:15 pm Gregory P. Casey

LEC Section: 01 MWF 8:30 am - 9:45 am Gregory P. Casey

LEC Section: 03 TR 11:20 am - 12:35 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.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Shyam Raman

LEC Section: 03 MWF 11:00 am - 12:15 pm Shyam Raman

LEC Section: 02 TR 8:30 am - 9:45 am David J. Zimmerman

Spring 2024

LEC Section: 01 Cancelled

LEC Section: 02 TR 9:55 am - 11:10 am Anand V. Swamy

LEC Section: 03 W 7:00 pm - 9:40 pm Thursday Org Mtg 6:30 pm - 6:55 pm David J. Zimmerman

ECON 360 (F) Monetary Economics (QFR)

This course covers a range of theoretical and applied issues bearing on monetary policy as conducted in the U.S. and abroad. Topics to be covered include: the causes of inflation, how central banks manage interest rates, the channels through which monetary policy affects the economy, and the costs and benefits of imposing rules on the conduct of policy. The class will also touch on a number of current issues facing central banks, such as unconventional monetary policy and cryptocurrencies.

Requirements/Evaluation: Two exams, a research paper and/or class presentation

Prerequisites: ECON 252 and 255. Multivariate calculus (MATH 150 or 151) is recommended but not required

Enrollment Limit: 20

Enrollment Preferences: junior and senior Economics majors

Expected Class Size: 20

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: The course entails the use of mathematical economic models, the presentation of quantitative information, and the interpretation of statistical analysis.

Fall 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Kenneth N. Kuttner

ECON 367 (S) The Political Economy of Social Insurance (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) (QFR)

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

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 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 endogeneous systems, and will then focus on associated methods for analysis of short 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 fields 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. Credit may not be earned for both ECON 371 and ECON 356.

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 2023

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

ECON 384 (S) 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. Additional topics may include issues in corporate risk management, corporate governance and corporate restructuring, such as mergers and acquisitions.

Class Format: Lecture / discussion

Requirements/Evaluation: Class participation, short assignments, and exams

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

Enrollment Limit: 28

Enrollment Preferences: Economics majors; seniority

Expected Class Size: 28

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

Distributions: (D2) (QFR)

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

Spring 2024

LEC Section: 01 MWF 8:30 am - 9:45 am 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

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,

Fall 2023

LEC Section: 01 Cancelled

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 514(D2) ECON 389(D2)

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

Spring 2024

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

ECON 475 (S) Advanced Economic Theory (QFR)

This course studies advanced topics in micro and macro economic theory. A major focus is on the mathematical underpinnings of advanced modern economics, with a particular emphasis on proofs. Topics may include existence of Nash equilibria, games of incomplete information, equilibrium refinement and selection, global games, Bayesian persuasion, Mirrless taxation, dynamic programming, existence of general equilibrium, recursive equilibria, stochastic models in continuous time, and others. The focus of this class is primarily on mathematical formalism, rigor, and proofs. These tools are essential components of any graduate program in economics. Students who wish to see pure math theorems applied to other fields may also be interested.

Requirements/Evaluation: May include problem sets, exams, participation, term paper

Prerequisites: MATH 150 or equivalent, ECON 251, or permission of instructor

Enrollment Limit: 19

Enrollment Preferences: Senior Economics Majors

Expected Class Size: 12

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: Mathematical modeling and proofs

Spring 2024

LEC Section: 01 Cancelled

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 514(D2) ECON 389(D2)

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

Spring 2024

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

ENVI 100 (S) Introduction to Weather and Climate (QFR)

Cross-listings: GEOS 100

Secondary Cross-listing

How is it that we have such a hard time predicting if it's going to rain next week, but we can be confident in projections of future climate change decades from now? This course will explore how fundamental laws of physics determine why air moves and changes, creating the wind, clouds, precipitation, and extreme events that form our weather. Building off of our understanding of the atmosphere, we'll look at longer time scales to develop an understanding of earth's climate system, global heat and moisture transport, climate change, and the ways that humans can change our planet. We will use weather and climate models to learn how scientists and meteorologists predict future conditions. Labs include benchtop experiments, data analysis projects, and self-scheduled meteorological observations. This course is in the Oceans and Climate group for the Geosciences major.

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

Prerequisites: none

Enrollment Limit: 60

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 60

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 100(D3) GEOS 100(D3)

Quantitative/Formal Reasoning Notes: This course will have regular problem sets which require substantial quantitative reasoning. Labs will require analysis, presentation, and explanation of quantitative data, and exams will require some quantitative problem solving.

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Alice C. Bradley

LAB Section: 02 M 12:30 pm - 2:30 pm Alice C. Bradley

LAB Section: 03 R 12:30 pm - 2:30 pm Alice C. Bradley

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

Unit Notes: satisfies the distribution requirement for the Biology major

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 t-tests, chi-square analysis, and regression.

Fall 2023

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 209 (F) Modern Climate (QFR)

Cross-listings: GEOS 309

Secondary Cross-listing

What will happen to the Earth's climate in the next century? What is contributing to sea level rise? Is Arctic sea ice doomed? In this course we will study the components of the climate system (atmosphere, ocean, cryosphere, biosphere and land surface) and the processes through which they interact. Greenhouse gas emission scenarios will form the basis for investigating how these systems might respond to human activity. This course will explore how heat and mass are moved around the atmosphere and ocean to demonstrate how the geographic patterns of climate change arise. We

will also focus on climate feedback effects--like the albedo feedback associated with sea ice and glacier loss--and how these processes can accelerate climate change. In labs we will learn MATLAB to use process and full-scale climate models to investigate the behavior of these systems in response to increasing greenhouse gasses in the atmosphere. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: 4 multi-week lab projects and several short quizzes

Prerequisites: Any of GEOS 100, GEOS 103, ENVI 102, GEOS 215, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: GEOS and ENVI 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 209(D3) GEOS 309(D3)

Quantitative/Formal Reasoning Notes: Lab projects consist of a series of numerical climate modeling projects, which require significant quantitative and logical reasoning.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Alice C. Bradley

LAB Section: 02 TBA Alice C. Bradley

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

Cross-listings: ECON 213

Secondary Cross-listing

We'll use economics to examine why we harm the environment and overuse natural resources, and what we can do about it. We'll study cost benefit analysis, pollution in general, climate change, 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 involved in 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)

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

Spring 2024

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

GEOS 100 (S) Introduction to Weather and Climate (QFR)

Cross-listings: ENVI 100

Primary Cross-listing

How is it that we have such a hard time predicting if it's going to rain next week, but we can be confident in projections of future climate change decades from now? This course will explore how fundamental laws of physics determine why air moves and changes, creating the wind, clouds, precipitation, and extreme events that form our weather. Building off of our understanding of the atmosphere, we'll look at longer time scales to develop an understanding of earth's climate system, global heat and moisture transport, climate change, and the ways that humans can change our planet. We will use weather and climate models to learn how scientists and meteorologists predict future conditions. Labs include benchtop experiments, data analysis projects, and self-scheduled meteorological observations. This course is in the Oceans and Climate group for the Geosciences major.

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

Prerequisites: none

Enrollment Limit: 60

Enrollment Preferences: first year and second year students, Geosciences majors

Expected Class Size: 60

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 100(D3) GEOS 100(D3)

Quantitative/Formal Reasoning Notes: This course will have regular problem sets which require substantial quantitative reasoning. Labs will require analysis, presentation, and explanation of quantitative data, and exams will require some quantitative problem solving.

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Alice C. Bradley

LAB Section: 02 M 12:30 pm - 2:30 pm Alice C. Bradley

LAB Section: 03 R 12:30 pm - 2:30 pm Alice C. Bradley

GEOS 309 (F) Modern Climate (QFR)

Cross-listings: ENVI 209

Primary Cross-listing

What will happen to the Earth's climate in the next century? What is contributing to sea level rise? Is Arctic sea ice doomed? In this course we will study the components of the climate system (atmosphere, ocean, cryosphere, biosphere and land surface) and the processes through which they interact. Greenhouse gas emission scenarios will form the basis for investigating how these systems might respond to human activity. This course will explore how heat and mass are moved around the atmosphere and ocean to demonstrate how the geographic patterns of climate change arise. We will also focus on climate feedback effects--like the albedo feedback associated with sea ice and glacier loss--and how these processes can accelerate climate change. In labs we will learn MATLAB to use process and full-scale climate models to investigate the behavior of these systems in response to increasing greenhouse gasses in the atmosphere. This course is in the Oceans and Climate group for the Geosciences major.

Requirements/Evaluation: 4 multi-week lab projects and several short quizzes

Prerequisites: Any of GEOS 100, GEOS 103, ENVI 102, GEOS 215, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: GEOS and ENVI 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 209(D3) GEOS 309(D3)

Quantitative/Formal Reasoning Notes: Lab projects consist of a series of numerical climate modeling projects, which require significant quantitative and logical reasoning.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Alice C. Bradley

LAB Section: 02 TBA Alice C. Bradley

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 2023

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 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Lori A. Pedersen

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 2023

LEC Section: 02 MWF 9:00 am - 9:50 am Bhagya Athukorallage

LEC Section: 01 MWF 8:00 am - 8:50 am Bhagya Athukorallage

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Lori A. Pedersen

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

Fall 2023

LEC Section: 02 MWF 11:00 am - 11:50 am Stewart D. Johnson

LEC Section: 01 MWF 10:00 am - 10:50 am Stewart D. Johnson

LEC Section: 03 MWF 12:00 pm - 12:50 pm Stewart D. Johnson

Spring 2024

LEC Section: 01 MWF 10:00 am - 10:50 am Mihai Stoiciu

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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Colin C. Adams

LEC Section: 02 MWF 10:00 am - 10:50 am Colin C. Adams

LEC Section: 03 MWF 11:00 am - 11:50 am Colin C. Adams

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.

Requirements/Evaluation: Fall: Homework, proof portfolio, group work, presentations, quizzes/exams, reflections. Spring: The grade will be based on homework and 4 exams.

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, and other fields of discrete mathematics.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Daniel Condon

LEC Section: 02 TR 11:20 am - 12:35 pm Daniel Condon

Spring 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

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:

MATH 210(D3) PHYS 210(D3)

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

Spring 2024

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.

Fall 2023

LEC Section: 02 MWF 11:00 am - 11:50 am Cesar E. Silva

LEC Section: 01 MWF 10:00 am - 10:50 am Cesar E. Silva

Spring 2024

LEC Section: 02 MWF 10:00 am - 10:50 am Palak Arora

LEC Section: 01 MWF 9:00 am - 9:50 am Palak Arora

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 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Julie C. Blackwood

Spring 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Bhagya Athukorallage

MATH 314 (F) Cryptography (QFR)

We will discuss some classical ciphers, current asymmetric cryptosystems (DES, AES, Rijndael), public key cryptosystems (RSA, Diffie-Hellman key exchange, ElGamal), and Error Correcting Codes. We will devote a substantial part of the semester covering the necessary mathematical background from number theory and asymptotic analysis. Time permitting, we may also discuss some special topics, such as primality testing (including the polynomial-time AKS algorithm), quantum computers, hash functions, digital signatures, zero-knowledge proofs, information theory, and elliptic curve cryptography.

Requirements/Evaluation: exams, problem sets, quizzes

Prerequisites: MATH 250 or permission of instructor.

Enrollment Limit: 30

Enrollment Preferences: Juniors and seniors.

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: The course will contain mathematical proofs.

Fall 2023

LEC Section: 01 TF 2:35 pm - 3:50 pm Leo Goldmakher

MATH 321 (S) Knot Theory (QFR)

Take a piece of string, tie a knot in it, and glue the ends together. The result is a knotted circle, known as a knot. For the last 100 years, mathematicians have studied knots, asking such questions as, "Given a nasty tangled knot, how do you tell if it can be untangled without cutting it open?" Some of the most interesting advances in knot theory have occurred in the last ten years. This course is an introduction to the theory of knots. Among other topics, we will cover methods of knot tabulation, surfaces applied to knots, polynomials associated to knots, and relationships between knot theory and chemistry and physics. In addition to learning the theory, we will look at open problems in the field.

Requirements/Evaluation: problem sets, midterms, a paper and a final exam

Prerequisites: MATH 250 or permission of instructor

Enrollment Limit: 30

Enrollment Preferences: seniors, junior, sophomores, first year

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a quantitative course.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Colin C. Adams

MATH 328 (S) Combinatorics (QFR)

Combinatorics is a branch of mathematics that focuses on enumerating, examining, and investigating the existence of discrete mathematical structures with certain properties. This course provides an introduction to the fundamental structures and techniques in combinatorics including enumerative methods, generating functions, partition theory, the principle of inclusion and exclusion, and partially ordered sets.

Class Format: interactive activities and discussion

Requirements/Evaluation: quizzes/exams, homework, activities

Prerequisites: "MATH 250, and MATH 200 or permission of instructor"

Enrollment Limit: 30

Enrollment Preferences: discretion of the instructor

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an upper level course in mathematics

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Daniel Condon

MATH 332 (F) Topics in Applied Linear Algebra (QFR)

This course focuses on applications of Linear Algebra. We will start with a review of the material covered in Math 250, then move on to more advanced topics and applications. We will cover Singular Value Decomposition (SVD), QR factorization, Cholesky factorization, Least Squares problems, the Taylor approximation, the Regression model, Clustering techniques, as well as Linear Dynamical Systems and some of their applications.

Requirements/Evaluation: Homework assignments and exams.

Prerequisites: Math 250

Enrollment Limit: 30

Enrollment Preferences: Mathematics Majors, Seniors

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 course, building upon the core course Math 250 - Linear Algebra.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Palak Arora

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:

MATH 341(D3) STAT 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

MATH 349 (F) Operations of Order (WS) (QFR)

One of the greatest challenges in mathematics is justifying interchanging orders of operations. Most of the time you cannot switch orders. Frequently this is obvious: the square root of a sum is typically not the sum of the square roots; however, there are many important situations where orders can be reversed. The purpose of this class is to highlight some of the difficulties and dangers in such attempts. This will be a writing intensive course, where we work on content for a book that collects counter-examples and theorems in one convenient place while also showcasing the utility of switching orders. We will discuss at great lengths how to do engaging, technical writing, keeping in mind the content and the audience. Students will receive feedback from the professor and probably other professional mathematicians and editors.

Requirements/Evaluation: Mix of homework, exams, and writing, including at least one chapter (consisting of theory, examples, images, homework problem creation and solutions).

Prerequisites: Math 250 or permission of the instructor.

Enrollment Limit: 19

Enrollment Preferences: If over-enrolled, students will be chosen uniformly at random.

Expected Class Size: 10

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

Distributions: (D3) (WS) (QFR)

Writing Skills Notes: Students will be working closely with me and colleagues, receiving feedback on their writing from numerous sources (myself, editors, experts in the field), and their work will be part of the final, published manuscript. We will have numerous discussions about how to write, taking into account the audience and the content.

Quantitative/Formal Reasoning Notes: This is a 300 level math course.

Fall 2023

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

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, oral exams, and possibly a take-home exam and/or an expository essay.

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: It's math.

Fall 2023

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

Spring 2024

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

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 2024

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

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 2023

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

Spring 2024

LEC Section: 02 TR 9:55 am - 11:10 am Steven J. Miller

LEC Section: 01 TR 8:30 am - 9:45 am Steven J. Miller

MATH 361 (S) 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.

Class Format: Students should sign up for lecture and one conference section.

Requirements/Evaluation: online multiple choice and short answer questions, weekly problem sets in groups, a research project, and a final

examination

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

Enrollment Limit: 60; 12/con

Enrollment Preferences: current or expected Computer Science majors

Expected Class Size: 60

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.

Spring 2024

CON Section: 06 W 3:00 pm - 4:00 pm Aaron M. Williams

LEC Section: 01 MR 2:35 pm - 3:50 pm Aaron M. Williams

CON Section: 05 W 2:00 pm - 3:00 pm Aaron M. Williams

CON Section: 02 W 11:00 am - 12:00 pm Aaron M. Williams

CON Section: 03 W 12:00 pm - 1:00 pm Aaron M. Williams

CON Section: 04 W 1:00 pm - 2:00 pm Aaron M. Williams

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 2024

TUT Section: T1 TBA Leo Goldmakher

MATH 383 (F) Complex Analysis (QFR)

The calculus of complex-valued functions turns out to have unexpected simplicity and power. As an example of simplicity, every complex-differentiable function is automatically infinitely differentiable. As examples of power, the so-called "residue calculus" permits the computation of "impossible" integrals, and "conformal mapping" reduces physical problems on very general domains to problems on the round disc. The easiest proof of the Fundamental Theorem of Algebra, not to mention the first proof of the Prime Number Theorem, used complex analysis.

Requirements/Evaluation: homework, classwork, and exams

Prerequisites: MATH 350 or MATH 351 or permission of instructor

Enrollment Limit: 40

Enrollment Preferences: 40

Expected Class Size: 30

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

Unit Notes: this course is not a senior seminar, so it does not fulfill the senior seminar requirement for the Math major

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Advanced mathematics course with weekly or daily problem sets.

Fall 2023

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

MATH 394 (S) Galois Theory (QFR)

Some equations--such as $x^5-1=0$ --are easy to solve. Others--such as $x^5-x-1=0$ --are very hard, if not impossible (using finite combinations of standard mathematical operations). Galois discovered a deep connection between field theory and group theory that led to a criterion for checking whether or not a given polynomial can be easily solved. His discovery also led to many other breakthroughs, for example proving the impossibility of squaring the circle or trisecting a typical angle using compass and straightedge. From these not-so-humble beginnings, Galois theory has become a fundamental concept in modern mathematics, from topology to number theory. In this course we will develop the theory and explore its applications to other areas of math.

Requirements/Evaluation: problem sets and oral exams

Prerequisites: MATH 355

Enrollment Limit: 30

Enrollment Preferences: Juniors and seniors

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a math class

Spring 2024

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

MATH 407 (F) Dance of the Primes (QFR)

Prime numbers are the building blocks for all numbers and hence for most of mathematics. Though there are an infinite number of them, how they are spread out among the integers is still quite a mystery. Even more mysterious and surprising is that the current tools for investigating prime numbers involve the study of infinite series. Function theory tells us about the primes. We will be studying one of the most amazing functions known: the Riemann Zeta Function. Finding where this function is equal to zero is the Riemann Hypothesis and is one of the great, if not greatest, open problems in mathematics. Somehow where these zeros occur is linked to the distribution of primes. We will be concerned with why anyone would care about this conjecture. More crassly, why should solving the Riemann Hypothesis be worth one million dollars? (Which is what you will get if you solve it, beyond the eternal fame and glory.)

Requirements/Evaluation: exams and weekly homework assignments

Prerequisites: MATH 350 or MATH 351, and MATH 355

Enrollment Limit: 30

Enrollment Preferences: seniors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: It is a math course.

Fall 2023

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

MATH 415 (F) Advanced Matrix Analysis (QFR)

This course will start with a review of various attributes of matrices (determinants, rank, etc), as well as eigenvalues, eigenvectors, and their properties. Then we will move on to study special matrices and their decompositions, along with similarities, and Jordan canonical forms. In the third segment, we will define norms on vectors and matrices and study their analytic properties. Finally, we will discuss another important class of matrices - positive definite and semidefinite matrices. If time permits, we will also cover positive and negative matrices and their properties.

Requirements/Evaluation: Homework assignments and exams.

Prerequisites: Math 350/351 or permission of instructor

Enrollment Limit: 25

Enrollment Preferences: Mathematics and Statistics Majors, Seniors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced mathematics class that covers complex properties of matrices and some of their applications.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Palak Arora

MATH 419 (F) Algebraic Number Theory (QFR)

We all know that integers can be factored into prime numbers and that this factorization is essentially unique. In more general settings, it often still makes sense to factor numbers into "primes," but the factorization is not necessarily unique! This surprising fact was the downfall of Lamé's attempted proof of Fermat's Last Theorem in 1847. Although a valid proof was not discovered until over 150 years later, this error gave rise to a new branch of mathematics: algebraic number theory. In this course, we will study factorization and other number-theoretic notions in more abstract algebraic settings, and we will see a beautiful interplay between groups, rings, and fields.

Requirements/Evaluation: homework assignments and exams

Prerequisites: MATH 355, or permission of instructor

Enrollment Limit: 25

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Fall 2023

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

MATH 434 (S) Applied Dynamics and Optimal Control (QFR)

We seek to understand how dynamical systems evolve, how that evolution depends on the various parameters of the system, and how we might manipulate those parameters to optimize an overall outcome. The primary focus of this course will be optimal control using Pontryagin's maximum principle and Hamilton-Jacobi-Bellman equations. These tools have broad application in ecology, economics, finance, and engineering, and we will draw on basic models from these fields to motivate our study. The course will begin with a solid review of modeling with dynamical systems, and

deepening our understanding of differential and difference equations, parameter dependence, and bifurcations.

Requirements/Evaluation: exams, homework assignments, and projects

Prerequisites: MATH 309 or PHYS 210, and MATH 350 or 351, or permission of the instructor

Enrollment Limit: 25

Enrollment Preferences: Preference will be given to senior math majors.

Expected Class Size: 20

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

Distributions: (D3) (QFR)

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

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Stewart D. Johnson

MATH 445 (S) Topics in Numerical Analysis (QFR)

Numerical analysis is a field of mathematics that focuses on developing algorithms and computational methods to solve problems that cannot be solved exactly. In this senior seminar course on numerical analysis we will cover advanced topics such as numerical solutions of Partial Differential Equations, Random Numbers and Monte Carlo simulation, Fast Fourier Transform and signal processing, as well as applications of the Singular Value Decomposition for matrices. The course will start with a review of basic concepts from calculus, linear algebra, and differential equations. Students who have taken Introduction to Numerical Analysis (Math 345) are welcome to take this course.

Requirements/Evaluation: exams and homework assignments

Prerequisites: Math 309 or Math 345 or permission of instructor

Enrollment Limit: 25

Enrollment Preferences: Mathematics Majors, Seniors

Expected Class Size: 25

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is a senior seminar course in mathematics.

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Bhagya Athukorallage

MATH 457 (S) Partition Theory (QFR)

The partitions of a positive integer are the different ways of writing it as a sum of positive integers. For example, 5 has seven partitions, three of which are $5=1+1+1+1+1$, $5=2+3$, and $5=5$. (Can you find the rest?) Partition theory is a rich area of combinatorics with applications to algebra and mathematical physics. In this class we will focus on enumerative and bijective methods to answer questions such as: How can we calculate the number of partitions of a number efficiently? Why is the number of partitions of N into strictly odd numbers always the same as the number of its partitions into distinct numbers? Why does a 2-dimensional partition look like a stack of cubes, and what does that have to do with tilings?

Requirements/Evaluation: Written homework; Written/Oral Exams; Project/Presentation

Prerequisites: A course in abstract algebra such as MATH 355, or permission of instructor.

Enrollment Limit: 25

Enrollment Preferences: Priority given to Junior and Seniors, and according to previous experience with subject.

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This is an advanced course in mathematics.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Daniel Condon

PHIL 203 (F) Logic and Language (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. We will examine the virtues and vices of good arguments in both informal and formal systems. The goals of this course are to improve the critical thinking of the students, to introduce them to sentential and predicate logic, to familiarize them with enough formal logic to enable them to read some of the great works of philosophy that use formal logic (such as Wittgenstein's *Tractatus*), and to examine some of the connections between logic and philosophy.

Class Format: discussion

Requirements/Evaluation: a midterm, a final, frequent homework and problem sets

Prerequisites: none

Enrollment Limit: 40/sect

Enrollment Preferences: Philosophy majors, seniors, juniors, sophomores, first-years in that order.

Expected Class Size: 40/sect

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

Distributions: (D2) (QFR)

Quantitative/Formal Reasoning Notes: The main part of the course is learning two formal languages of logic: sentential logic and predicate logic

Fall 2023

LEC Section: 01 MWF 10:00 am - 10:50 am Steven B. Gerrard

LEC Section: 02 MWF 12:00 pm - 12:50 pm Steven B. Gerrard

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:

COGS 224(D2) PHIL 221(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).

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Christian De Leon

PHIL 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHYS 312 / STS 312

Secondary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and Physics 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 312(D2) PHYS 312(D3) STS 312(D2)

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland

PHYS 109 (S) Sound, Light, and Perception (QFR)

Light and sound allow us to perceive the world around us, from appreciating music and art to learning the details of atomic structure. Because of their importance in human experience, light and sound have long been the subject of scientific inquiry. How are sound and light related? How do physiology and neural processing allow us to hear and see the world around us? What are the origins of color and musical pitch? This course introduces the science and technology of light and sound to students not majoring in physics. We will start with the origins of sound and light as wave phenomena, and go on to topics including color, the optics of vision, the meaning of musical pitch and tone, and the physical basis of hearing. We will also discuss some recent technological applications of light, such as lasers and optical communications. The class will meet for two 75-minute periods each week for a variable mixture of lecture, discussion, and hands-on, interactive experiments.

Class Format: The two weekly class sections will be located in a space suitable for both lecture and hands-on laboratory-style work

Requirements/Evaluation: class participation, problem sets, in-class midterm, oral presentations, and a final exam, all with a quantitative component

Prerequisites: none

Enrollment Limit: 20

Enrollment Preferences: non-science majors

Expected Class Size: 20

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This class will have frequent problem sets requiring substantial quantitative reasoning

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Catherine Kealhofer

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: 30

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 2023

LEC Section: 01 MWF 11:00 am - 11:50 am John H. Lacy

LAB Section: 02 M 1:00 pm - 4:00 pm Brough Morris

LAB Section: 03 T 1:00 pm - 4:00 pm Brough Morris

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 2024

LEC Section: 01 MWF 11:00 am - 11:50 am Protik K. Majumder

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 2023

LEC Section: 01 MWF 11:00 am - 11:50 am Katharine E. Jensen

LAB Section: 03 T 1:00 pm - 4:00 pm Katharine E. Jensen

LAB Section: 02 M 1:00 pm - 4:00 pm Katharine E. Jensen

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

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 2024

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

LEC Section: 01 MWF 11:00 am - 11:50 am 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 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Daniel P. Aalberts

LAB Section: 02 W 1:10 pm - 3:50 pm Daniel P. Aalberts

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 take-home 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 2023

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 209 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 2024

LAB Section: 02 T 1:00 pm - 4:00 pm Charlie Doret

LEC Section: 01 MWF 10:00 am - 10:50 am Charlie Doret

LAB Section: 03 W 1:00 pm - 4:00 pm Charlie Doret

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:

MATH 210(D3) PHYS 210(D3)

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

Spring 2024

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

PHYS 301 (F) Quantum Physics (QFR)

This course serves as a one-semester introduction to the formalism, and phenomenology of quantum mechanics. After a brief discussion of historical origins of the quantum theory, we introduce 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: 20

Enrollment Preferences: physics majors

Expected Class Size: 15

Grading: no pass/fail option, yes 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 2023

LEC Section: 01 MWF 9:00 am - 9:50 am Protik K. Majumder

LAB Section: 02 M 1:00 pm - 4:00 pm John H. Lacy

LAB Section: 03 T 1:00 pm - 4:00 pm John H. Lacy

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, midterm exam, final exam, and labs, 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: 20

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

Spring 2024

LEC Section: 01 MWF 9:00 am - 9:50 am Katharine E. Jensen

LAB Section: 02 W 1:00 pm - 4:00 pm Katharine E. Jensen

PHYS 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHIL 312 / STS 312

Primary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and 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:

PHIL 312(D2) PHYS 312(D3) STS 312(D2)

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland

PHYS 314 (S) Controlling Quanta (QFR)

This course will explore modern developments in the control of individual quantum systems. Topics covered will include basic physical theories of atoms coupled to photons, underlying mathematical tools (including Lie algebras and groups), and computational methods to simulate and analyze quantum systems. Applications to quantum computing, teleportation, and experimental metaphysics (Bell's inequality) will also be discussed.

Requirements/Evaluation: tutorial preparation and participation, weekly problem sets/papers, and a final project

Prerequisites: PHYS/MATH 210 or MATH 209 or MATH 250

Enrollment Limit: 10

Enrollment Preferences: sophomores and junior Physics majors

Expected Class Size: 10

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course involves weekly problems sets involving linear algebra, calculus, and other mathematical methods.

Spring 2024

TUT Section: T1 F 1:10 pm - 2:25 pm Frederick W. Strauch

PHYS 405 (F) Electromagnetic Theory (QFR)

This course builds on the material of Physics 201, and explores the application of Maxwell's Equations to understand a range of topics including electric fields and matter, magnetic materials, light, and radiation. As we explore diverse phenomena, we will learn useful approximation techniques and beautiful mathematical tools. In addition to weekly tutorial meetings, the class will meet once a week as a whole to introduce new material.

Class Format: Class will meet once as a whole to introduce new material and for informal discussion.

Requirements/Evaluation: weekly problem sets, tutorial participation, presentations, and a final exam or final project, all of which have a substantial quantitative component

Prerequisites: PHYS 202 and PHYS/MATH 210 or MATH 209 or MATH 309

Enrollment Limit: 30

Enrollment Preferences: Preference will be given to physics and astrophysics majors.

Expected Class Size: 18

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Physics courses are all heavily dependent on QFR skills. Phys 405 will feature extensive use of vector calculus and differential equations while also asking students to develop facility with approximation techniques in solving complex problems throughout the semester.

Fall 2023

TUT Section: T1 F 1:10 pm - 2:25 pm Charlie Doret

PHYS 418 (S) Gravity (QFR)

This course is an introduction Einstein's theory of general relativity. We begin with a review of special relativity, emphasizing geometrical aspects of Minkowski spacetime. Working from the equivalence principle, we then motivate gravity as spacetime curvature, and study in detail the Schwarzschild geometry around a spherically symmetric mass. After this application, we use tensors to develop Einstein's equation, which describes how energy density curves spacetime. With this equation in hand we study the Friedmann-Robertson-Walker geometries for an expanding universe, and finally, we linearize Einstein's equation to develop the theory of gravitational waves.

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

Prerequisites: PHYS 301 or PHYS 405 or PHYS 411, or permission of instructor

Enrollment Limit: none

Enrollment Preferences: none

Expected Class Size: 10

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

Distributions: (D3) (QFR)

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

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm David R. Tucker-Smith

POEC 253 (F) Empirical Methods in Political Economy (QFR)

This course introduces students to common empirical tools used in policy analysis and implementation. The broad aim is to train students to be discriminating consumers of public policy-relevant research. The emphasis in the course is on intuitive understanding of the central concepts. 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; random variables and distributions; statistical estimation, inference and hypothesis testing; and modeling using multiple regression, with a particular focus on understanding whether and how relationships between variables can be determined to be causal--an essential requirement for effective policy formation. 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) (QFR)

Quantitative/Formal Reasoning Notes: The course teaches econometrics, i.e. statistics as economists use it, with applications in economics, political science, and other fields.

Fall 2023

LEC Section: 01 TF 2:35 pm - 3:50 pm Anand V. Swamy

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.

Fall 2023

LAB Section: A2 W 1:00 pm - 4:00 pm Steven Fein

LEC Section: B3 TR 8:30 am - 9:45 am Noah J. Sandstrom

LEC Section: A1 TR 11:20 am - 12:35 pm Steven Fein

LAB Section: B4 R 1:00 pm - 4:00 pm Noah J. Sandstrom

Spring 2024

LEC Section: B3 TR 11:20 am - 12:35 pm Kris N. Kirby

LAB Section: B4 W 1:00 pm - 4:00 pm Kris N. Kirby

LAB Section: C6 T 1:00 pm - 4:00 pm Catherine B. Stroud

LEC Section: C5 MR 1:10 pm - 2:25 pm Catherine B. Stroud

LEC Section: A1 TR 11:20 am - 12:35 pm Steven Fein

LAB Section: A2 W 1:00 pm - 4:00 pm Steven Fein

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.

Fall 2023

LEC Section: 01 MWF 8:30 am - 9:45 am Bernhard Klingenberg

Spring 2024

LEC Section: 01 TF 1:10 pm - 2:25 pm Xizhen Cai

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

Fall 2023

LEC Section: 02 MWF 10:00 am - 10:50 am Norean R. Sharpe

LEC Section: 01 MWF 9:00 am - 9:50 am Norean R. Sharpe

Spring 2024

LEC Section: 02 MW 11:00 am - 12:15 pm Norean R. Sharpe

LEC Section: 01 MW 8:30 am - 9:45 am Norean R. Sharpe

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.

Fall 2023

LEC Section: 01 MWF 11:00 am - 11:50 am Anna M. Plantinga

Spring 2024

LEC Section: 01 MWF 11:00 am - 12:15 pm Anna M. Plantinga

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.

Fall 2023

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

LEC Section: 01 TR 8:30 am - 9:45 am Shaoyang Ning

Spring 2024

LEC Section: 01 TR 8:30 am - 9:45 am Shaoyang Ning

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.

Spring 2024

LEC Section: 01 MWF 8:30 am - 9:45 am 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:

MATH 341(D3) STAT 341(D3)

Quantitative/Formal Reasoning Notes: This is a 300-level Math/Stat course.

Fall 2023

LEC Section: 01 TR 9:55 am - 11:10 am Thomas A. Garrity

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Thomas A. Garrity

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, theory and data analysis exams, 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 2023

LEC Section: 01 MWF 8:30 am - 9:45 am Anna M. Plantinga

Spring 2024

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 is necessary to analyze and describe such datasets with more than multiple variables. Topics covered will include data visualization techniques for high dimensional data sets, parametric and non-parametric techniques to estimate joint distributions, techniques for combining variables and making inferences, and several classification and clustering algorithms.

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 2023

LEC Section: 01 TR 9:55 am - 11:10 am 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 2023

LEC Section: 01 MWF 11:00 am - 12:15 pm Bernhard Klingenberg

STAT 365 (S) Bayesian Statistics (QFR)

The Bayesian approach to statistical inference represents a reversal of traditional (or frequentist) inference, in which data are viewed as being fixed and model parameters as unknown quantities. Interest and application of Bayesian methods have exploded in recent decades, being facilitated by recent advances in computational power. We begin with an introduction to Bayes' Theorem, the theoretical underpinning of Bayesian statistics which dates back to the 1700's, and the concepts of prior and posterior distributions, conjugacy, and closed-form Bayesian inference. Building on this, we introduce modern computational approaches to Bayesian inference, including Markov chain Monte Carlo (MCMC), Metropolis-Hastings sampling, and the theory underlying these simple and powerful methods. Students will become comfortable with modern software tools for MCMC using a variety of applied hierarchical modeling examples, and will use R for all statistical computing.

Requirements/Evaluation: weekly homework and exams

Prerequisites: MATH/STAT 341 and STAT 346, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: juniors and seniors, Statistics majors, students who have taken STAT 360

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course utilizes mathematics and computer-based tools for the Bayesian approach for analyzing data and making statistical inferences.

Spring 2024

LEC Section: 01 Cancelled

STAT 440 (S) Categorical Data Analysis (QFR)

This course focuses on methods for analyzing categorical response data. Traditional tools of statistical data analysis for continuous response data are not designed to handle such data and pose inappropriate assumptions. We will develop methods specifically designed to address the discrete nature of the observations and consider many applications in the social and biological sciences as well as in medicine, engineering and economics. The first part of the course will discuss statistical inference for parameters of categorical distributions and arising in contingency tables. The longer second part will focus on statistical modeling via generalized linear models for binary, multinomial, ordinal and count response variables, using maximum likelihood.

Requirements/Evaluation: Class participation and performance on exams, homework, and a project.

Prerequisites: STAT 346 and STAT 360

Enrollment Limit: 15

Enrollment Preferences: seniors and statistics majors

Expected Class Size: 12

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: Arguing with data.

Spring 2024

LEC Section: 01 Cancelled

STAT 442 (F) 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.

Fall 2023

LEC Section: 01 TF 1:10 pm - 2:25 pm Shaoyang Ning

STAT 465 (S) Bayesian Statistics (QFR)

Prior knowledge being constantly updated by empirical observations -- the essence of Bayesian thinking provides a natural, intuitive, and more importantly, mathematically sounded, probabilistically principled way to characterize the process of learning. With some of its key ideas formulated based on Bayes' Theorem dating back to 18th century, Bayesian inference is one of oldest schools of statistics (more than a century earlier than the Frequentist!). Yet it was not until the recent developments in sampling algorithms and computational powers that Bayesian inference gained its revival. Bayesian, and Bayesian-based methods, with their flexibilities in modeling (generative) process of data, interpretability with posterior probability statements, and coherent principles to incorporate empirical evidence a priori, have played key roles in modern data analysis, especially for those "big data" with enhanced complexity and connectivity. This course is designed to provide students a comprehensive understanding to what is Bayesian and the how's and why's. Students will be introduced to classic Bayesian models, basic computational algorithms/methods for Bayesian inference, as well as their applications in various fields, and comparisons with classic Frequentist methods. As Bayesian inference finds its roots and merits particularly in application, this course puts great emphasis on enhancing students' skills in statistical computation (mostly with R) and data analysis.

Requirements/Evaluation: Homework, exams, and project

Prerequisites: MATH/STAT 341, STAT 346, and STAT 360, or permission of instructor

Enrollment Limit: 20

Enrollment Preferences: seniors, Statistics majors

Expected Class Size: 15

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

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course utilizes mathematics and computer-based tools for the Bayesian approach for analyzing data and making statistical inferences.

Spring 2024

LEC Section: 01 TR 11:20 am - 12:35 pm Shaoyang Ning

STS 312 (F) Philosophical Implications of Modern Physics (QFR)

Cross-listings: PHIL 312 / PHYS 312

Secondary Cross-listing

Some of the discoveries made by physicists over the last century seem to show that our common sense views are deeply at odds with our most sophisticated and best confirmed scientific theories. The course will present the essential ideas of relativity theory and quantum theory and explore their implications for philosophy. We will ask, for example, what these theories tell us about the nature of space, time, probability and causality.

Requirements/Evaluation: attendance, participation, problem sets, exams, six 1- to 2-page papers and a 12- to 15-page term paper

Prerequisites: MATH 140, high-school physics, and either a 200-level course in PHIL or a 100-level course in PHYS

Enrollment Limit: 20

Enrollment Preferences: Philosophy majors and Physics 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 312(D2) PHYS 312(D3) STS 312(D2)

Fall 2023

LEC Section: 01 MR 2:35 pm - 3:50 pm Frederick W. Strauch, Keith E. McPartland