College of Sciences

The UMass Lowell College of Sciences, led by Dr. Mark Hines, fosters critical and creative thinking for future solutions to environmental, economic and human problems, while helping students to develop the capacity to respond to a changing world.

A wide range of ongoing research and project opportunities exist within the various degree programs, and interdisciplinary study is emphasized. Graduates of these programs are heavily recruited both regionally and nationally by industry and governmental agencies.

Policy

- Facilities
- Honor & Professional Societies
- Mission of the College of Sciences
- Organization and Governance
- Policies and Requirements

Programs

- Programs in Sciences
- Biological Sciences
- Chemistry
- Computer Science
- Environmental, Earth, and Atmospheric Sciences
- Mathematical Sciences
- Physics

Programs in the Sciences

The science and mathematics departments of the UMass Lowell College of Sciences offer undergraduate programs leading to the Bachelor of Science degree. Students who matriculate for the degree of Bachelor of Science may pursue majors in Biological Sciences, Chemistry, Computer Science, Environmental, Earth and Atmospheric Sciences, Mathematical Sciences, and Physics and Applied Physics.

Students should consult the Graduate Catalog for information concerning master’s programs in Biological Sciences, Chemistry, Computer Science, Mathematics, Physics and Applied Physics, Polymer Science, Radiological Sciences and Protection, and doctoral programs in Chemistry, Computer Science, Physics and Applied Physics.

In addition to satisfying general University requirements for Bachelor's degrees as are defined elsewhere in this publication under the heading Academic Policies: Baccalaureate Degrees, students who matriculate for degrees in the College of Sciences also must complete a specific minimum number of courses and credits in the College of Sciences. These college requirements are described below. Except as specified by the college and program restrictions, students are permitted to elect any course for which they can satisfy prerequisite requirements in fulfilling an unrestricted elective requirement. However, in order to designate courses from other colleges of the University as science or mathematics courses, students must petition the chairperson of the department in which they are enrolled as majors.

Minor areas of study are offered by all science departments. College majors may also wish to consider minors offered by the social sciences, humanities, and fine arts departments, and specialized course sequences of the College of Engineering. All minor programs of the University require 18-24 credits, six of which must be at the 300 course level or above.

Bachelor of Science Degree

The Bachelor of Science degree is designed to provide a specialized education in one or more of the basic sciences. Specialized Bachelor of Science curricula, which are offered in areas of science and mathematics, provide opportunities for major and minor program options but afford greater opportunities for major specialization than are permitted in comparable Bachelor of Arts curricula.

All Bachelor of Science programs require, as a minimum, 74 credits and 20 courses from the offerings of the science and mathematics departments. At least three courses are required in mathematics beyond pre-calculus mathematics and must include two calculus courses and one additional mathematics elective.

Four science lecture courses with co-requisite laboratories are required. These are selected from approved courses in each department and must include a two-semester sequence from one department outside the student’s major.

For University policies concerning majors presented for the Bachelor of Science degree, see policies under the heading Academic Policies: Major Field Requirements.

Below is a list of major fields for the BS degree currently offered in the College of Sciences. Students need not choose an option or
Concentration.

1. **Biological Science**
   1. Bioinformatics Option
   2. Biotechnology Option
   3. Ecology Option
2. **Chemistry**
   1. Cheminformatics Option
   2. Forensics Option
3. **Computer Science**
   1. Bio/Cheminformatics Option
4. **Environmental Science**
   1. Atmospheric Science Concentration
   2. Environmental Studies Concentration
   3. Geoscience Concentration
5. **Mathematics**
   1. Applied/Computational Mathematics Option
   2. Bioinformatics Concentration
   3. Business Applications Concentration
   4. Computer Science Concentration
   5. Probability/Statistics Concentration
   6. Teaching Concentration
6. **Physics**
   1. Optics Option
   2. Radiological Health Physics Option

**College Requirements for Science Students**

In order to qualify for a Bachelor's degree offered by the science and mathematics departments of the College of Sciences, undergraduates must comply with the University general education requirements, must conform to the rules of the College of Sciences that govern degree and major studies for such degrees, and must earn 2.000 averages in their major fields by the end of their senior year.

**Environmental Geoscience Option**

The Environmental Geoscience option is designed for students who have an interest in the physical environment, but desire a broader preparation than that of the traditional geology major. The focus is on Earth Systems Science and a strong geoscience core is supplemented by additional courses in the biological sciences and geographical information systems. A suite of technical electives allows the student, in consultation with his/her advisor, to further deepen his/her understanding of a particular area of Earth Systems Science. Students who follow this program will not only be prepared for entry into the traditional areas of geological employment (petroleum and mining) but also for the expanding opportunities in hydrogeology, hazardous waste assessment and management, groundwater remediation, wetlands delineation and evaluation, and environmental management. Students who graduate from this option are also well prepared to continue their education at the graduate level in the geosciences or environmental sciences.

**General Education courses (24 credits)**

**Basic Science and Mathematics courses (35 credits):**

- Calculus I (4 credits), Calculus II (4 credits), Math elective (3 credits)
- Chemistry I + Lab (4 credits), Chemistry II + Lab (4 credits)
- General Physics I + Lab (4 credits), General Physics II + Lab (4 credits)
- Principles of Biology I + Experimental Biology I (4 credits), Principles of Biology II + Experimental Biology II (4 credits)

**Core Science courses (41 credits):**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>87.101</td>
<td>Environmental Science Seminar</td>
<td>1</td>
</tr>
<tr>
<td>87.102</td>
<td>Environmental Problems Seminar</td>
<td>1</td>
</tr>
<tr>
<td>87.201</td>
<td>Principles of Earth &amp; Environmental Systems I</td>
<td>3</td>
</tr>
<tr>
<td>87.202</td>
<td>Principles of Earth &amp; Environmental Systems II</td>
<td>3</td>
</tr>
<tr>
<td>87.203</td>
<td>Principles of Earth &amp; Environmental Systems I Lab</td>
<td>1</td>
</tr>
<tr>
<td>87.204</td>
<td>Principles of Earth &amp; Environmental Systems II Lab</td>
<td>1</td>
</tr>
<tr>
<td>89.314</td>
<td>Hydrogeology</td>
<td>3</td>
</tr>
<tr>
<td>89.315</td>
<td>Environmental Geochemistry</td>
<td>4</td>
</tr>
<tr>
<td>89.317</td>
<td>Principles of Ecology</td>
<td>3</td>
</tr>
<tr>
<td>87.301</td>
<td>GIS in Earth and Environmental Sciences</td>
<td>3</td>
</tr>
<tr>
<td>89.307</td>
<td>Earth Materials I</td>
<td>3</td>
</tr>
</tbody>
</table>
Science Electives (12 - 20 credits):

Four courses selected in consultation with the Academic Advisor. Courses that can be used for these electives are listed below. Courses not listed below may be used upon written approval by the department chair.

Geoscience:

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<tbody>
<tr>
<td>89.304</td>
<td>Igneous and Metamorphic Petrology</td>
<td>3</td>
</tr>
<tr>
<td>89.306</td>
<td>Igneous and Metamorphic Petrology Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>89.322</td>
<td>Structural Geology</td>
<td>3</td>
</tr>
<tr>
<td>89.324</td>
<td>Structural Geology Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>89.341</td>
<td>Environmental and Engineering Geology</td>
<td>3</td>
</tr>
<tr>
<td>89.352</td>
<td>Sedimentation and Stratigraphy</td>
<td>3</td>
</tr>
<tr>
<td>89.354</td>
<td>Sedimentation and Stratigraphy Laboratory</td>
<td>1</td>
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<tr>
<td>89.424</td>
<td>Regional Hydrogeology</td>
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<tr>
<td>89.452</td>
<td>Advanced Geochemistry</td>
<td>3</td>
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<tr>
<td>89.456</td>
<td>Applied Geophysics</td>
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</tr>
<tr>
<td>89.495</td>
<td>Honors Research Geology</td>
<td>3</td>
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<tr>
<td>89.501</td>
<td>Paleoclimatology</td>
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<tr>
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<td>Microbiology</td>
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</tr>
<tr>
<td>81.303</td>
<td>Microbiology Laboratory</td>
<td>1</td>
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<tr>
<td>81.320</td>
<td>Botany</td>
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<tr>
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</tr>
<tr>
<td>81.404</td>
<td>Environmental Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>81.423</td>
<td>Biology of Global Change</td>
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Chemistry:

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<tbody>
<tr>
<td>84.221</td>
<td>Organic Chemistry IA</td>
<td>3</td>
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<tr>
<td>84.229</td>
<td>Organic Chemistry Laboratory IA</td>
<td>1</td>
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<tr>
<td>84.222</td>
<td>Organic Chemistry IIA</td>
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<td>Analytical Chemistry Laboratory II</td>
<td>2</td>
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<tr>
<td>84.344</td>
<td>Physical Chemistry I</td>
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View the complete [Course of Study](pdf)

### Geoscience Minor

A minor in Geoscience consists of 8 credits of required courses and four additional courses (12-16 credits) from the list of Geoscience Electives.

#### Required Core Courses:

- Earth Materials I Lab 1 credit
- Earth Materials II 3 credits
- Earth Materials II Lab 1 credit
- Surface Processes 3 credits
- Surface Processes Lab 1 credit
- Earth History 3 credits
- Earth History Lab 1 credit

- Science Electives (12 - 20 credits):

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</table>
87.201/87.203 Principles of Earth and Environmental Systems I + Laboratory
87.202/87.204 Principles of Earth and Environmental Systems II + Laboratory
89.101/89.103 General Geology + Laboratory (or equivalent) can be substituted for 87.201/203.

Geoscience Electives (4 courses):

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<tbody>
<tr>
<td>89.215</td>
<td>Forensic Geology</td>
</tr>
<tr>
<td>89.304/89.306</td>
<td>Igneous and Metamorphic Petrology + Laboratory</td>
</tr>
<tr>
<td>89.307/89.309</td>
<td>Earth Materials I + Laboratory</td>
</tr>
<tr>
<td>89.308/89.310</td>
<td>Earth Materials II + Laboratory</td>
</tr>
<tr>
<td>89.314</td>
<td>Hydrogeology</td>
</tr>
<tr>
<td>89.315</td>
<td>Environmental Geochemistry</td>
</tr>
<tr>
<td>89.319/89.321</td>
<td>Surface Processes + Laboratory</td>
</tr>
<tr>
<td>89.322/89.324</td>
<td>Structural Geology + Laboratory</td>
</tr>
<tr>
<td>89.326</td>
<td>Glacial and Pleistocene Geology</td>
</tr>
<tr>
<td>89.331/89.333</td>
<td>Earth History + Laboratory</td>
</tr>
<tr>
<td>89.352/89.354</td>
<td>Sedimentation and Stratigraphy + Laboratory</td>
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Or any other course at the 300 level or above with an 89 prefix.

**81.111 Principles of Biology I**

Course ID: 7466

Course Details: Introduces topics such as the chemical and physical basis of life, its evolution, diversity, distribution, and interrelationships of life forms. The central theme of genetic replication, translation, expression, and selection will be emphasized as a unifying principle which determines and integrates structure and function at the cellular, individual population, and community levels of organization. Designed for those students who intend to pursue career options in the biological sciences, biotechnology or related areas such as medicine, biomedical research, radiological sciences or environmental sciences. It is the first-semester course of a two-semester sequence.

Max Credits: 3
Min Credits: 3

**81.112 Principles of Biology II**

Course ID: 7467

Course Details: Serves as a continuation of the 81.111/81.112 sequence for those students who intend to pursue career options in the biological sciences or related professional areas such as medicine, biomedical research or environmental sciences. Molecular energy exchange in organisms (photosynthesis and respiratory metabolism), the common functional needs of support, locomotion, nutrition, internal communication and the maintenance of homeostasis are considered. Control and regulation of organisms at levels beyond the individual are considered through discussions of population and community ecology.

Max Credits: 3
Min Credits: 3

**81.115 Introduction To Biology Seminar**

Course ID: 7470

Course Details: Freshman Seminar in Biology (Honors section available) This course offers a small group seminar format for problem solving and discussion with faculty and staff. It is designed for individual participation in exploring concepts related to material considered in Principles of Biology I and II (81.111 and 81.112). Required of freshman students; optional, with permission of instructor, to others registered in lecture section.

Max Credits: 1
Min Credits: 1

**81.116 Freshman Seminar in Biology**

Course ID: 7471
Course Details: This course is designed to acclimate incoming students to their new University environment. Students will learn about the Biology program, its faculty and staff members, University resources, and other information useful for success.

Max Credits: 1
Min Credits: 1

**81.117 Experimental Biology I**

Course ID: 7472

Max Credits: 1
Min Credits: 1

**81.118 Experimental Biology II**

Course ID: 7473

Max Credits: 1
Min Credits: 1

**81.122 Biology for Health Sciences**

Course ID: 38070

Course Details: Develops a basic understanding of biological topics relevant to students in the health sciences. Course will introduce students to biochemistry, cell biology, cellular respiration, cell replication, genetics, inheritance and molecular biology. Introduction to prions, viruses, prokaryotic and eukaryotic biology will also be covered.

Max Credits: 3
Min Credits: 3

**81.124 Biology for Health Sciences Lab**

Course ID: 38071

Course Details: Develops a basic understanding of biological topics relevant to students in the health sciences. Course will introduce students to biochemistry, cell biology, cellular respiration, cell replication, genetics, inheritance and molecular biology. Introduction to prions, viruses, prokaryotic and eukaryotic biology will also be covered.

Max Credits: 1
Min Credits: 1

**81.201 General Microbiology**

Course ID: 7474

Course Details: A study of the general properties of bacteria and viruses (anatomy, physiology, genetics, metabolism, cultivation, and growth); discussions include major microbial infections in man (etiologic agent, antibiotics and chemotherapy) and an examination of the role of the microbes in the environment.

Max Credits: 3
Min Credits: 3

**81.203 General Microbiology Laboratory**

Course ID: 7475

Course Details: A series of laboratory exercises covering basic qualitative and quantitative techniques commonly employed in a microbiology laboratory.

Max Credits: 2
81.210 Biology for Engineers

Course ID: 37711

Course Details: Develops a basic understanding of the science of biology for engineering students, including and introduction to biochemistry, cell biology, metabolism, genetics, genomics, molecular biology, cell growth, and nutrition. Both eukaryotic and prokaryotic biology will be covered.

Max Credits: 3
Min Credits: 3

81.212 Biology for Engineers Laboratory

Course ID: 37712

Course Details: This laboratory course will build on 81.210. It will provide an introduction to several basic biological techniques and approaches used in biological engineering laboratories.

Max Credits: 1
Min Credits: 1

81.220 Principles of Cell and Molecular Biology

Course ID: 37710

Course Details: This course will cover basic topics in cell and molecular biology, including structures of proteins, lipids, carbohydrates and nucleic acids, structure of DNA and its replication and repair, transcription, and cell-cell communication. The molecular biology of cells and the regulation of cellular processes will be emphasized.

Max Credits: 3
Min Credits: 3

81.233 Experimental Methods in Biology

Course ID: 37713

Course Details: This is a project-based course designed to introduce students to the methods of general biological laboratory research. Techniques will be introduced in the context of interrelated experiments during a semester-long project. Techniques will include, but are not limited to: making solutions, pipetting, using sterile technique, gel electrophoresis, DNA transformations, minipreps, and other molecular and microscopic methods.

Max Credits: 2
Min Credits: 2

81.235 Genetics

Course ID: 36858

Course Details: The theories of both classical and molecular genetics are explored with emphasis on the experimental evidence which has laid the foundation for contemporary understanding of genetics, included is the nature of the genetic material, gene action, genetic recombination, gene regulation, gene interaction, the production and inheritance of genetic phenotypes, chromosomal mechanics, and the behavior of genes in populations.

Max Credits: 3
Min Credits: 3

81.237 Problems in Genetics

Course ID: 36859

Course Details: Techniques of genetic analysis using molecular, prokaryotic and eukaryotic systems. There is an emphasis on problem solving and statistical methods.
**81.240 Evolution, Ecology and Conservation**

Course ID: 37718

Course Details: Over 5 million species thrive in amazingly diverse habitats on Earth ranging from the extreme freezing cold of the poles to the lush warmth of the tropics. How did this fantastic diversity arise on our earth? How are these species intimately interconnected with one another, their communities and their ecosystem? How can we save this remarkable biodiversity from extinction? This course will address these key questions by examining the fundamental concepts of evolution, ecology and conservation biology. Students will be expected to attend a discussion section in which they will examine case studies and primary scientific literature.

Max Credits: 3
Min Credits: 3

**81.242 Problems in Evolution, Ecology and Conservation**

Course ID: 37714

Course Details: A discussion session designed to reinforce material presented in 81.240, Evolution, Ecology and Conservation. An emphasis will be placed on problem solving.

Max Credits: 1
Min Credits: 1

**81.252 Physiology**

Course ID: 7481

Course Details: Presents a comprehensive study of the fundamental mechanisms governing mammalian physiology. The role of cell physiology in determining systemic functions and coordinating biological control systems will be emphasized. Maintenance of homeostasis will be discussed in terms of biochemical, cytological, anatomical, and physical principles.

Max Credits: 3
Min Credits: 3

**81.254 Physiology Laboratory**

Course ID: 7482

Course Details:
Max Credits: 2
Min Credits: 2

**81.300 Directed Research Experience II**

Course ID: 7485

Course Details:
Max Credits: 2
Min Credits: 2

**81.301 Microbiology**

Course ID: 36856

Course Details: General properties of bacteria and viruses including anatomy, physiology, genetics, metabolism, cultivation, growth, control and their role in the ecosystems, and industry.

Max Credits: 3
Min Credits: 3
81.303 Microbiology Laboratory
Course ID: 36855
Course Details: A series of laboratory exercises covering basic qualitative and quantitative techniques commonly employed in a microbiology laboratory including sterile technique, microscopy, enrichment and isolation, and prevention.
Max Credits: 2
Min Credits: 2

81.306 Invertebrate Zoology
Course ID: 7487
Course Details: A survey of the phyla of invertebrate animals. Discussions include their physiology, development, morphology, behavior, ecology and adaptations. Corequisite: 81.308
Max Credits: 3
Min Credits: 3

81.308 Invertebrate Zoology Lab
Course ID: 7488
Course Details: A broad spectrum of living and preserved specimens are studied in the laboratory with regard to both structure and function. Corequisite 81.306
Max Credits: 1
Min Credits: 1

81.315 Principles of Ecology
Course ID: 7491
Course Details: A series of lectures concerned with the interrelationships of organisms with their abiotic environment with emphasis on the New England area. Selected current topics will supplement the text.
Max Credits: 3
Min Credits: 3

81.317 Principles of Ecology Laboratory
Course ID: 7492
Course Details: A series of laboratory exercises to supplement and illustrate lectures of 81.315. Field trips are an integral part of the course involving sampling and analysis of such ecosystem components as water, soil, invertebrate fauna and characteristic flora of various habitats. Directed readings, quizzes, practical exam and oral presentation of a research topic are integral parts of the course.
Max Credits: 2
Min Credits: 2

81.320 Botany
Course ID: 7493
Course Details: Serves as an introduction to the study of the plant kingdom dealing with the structure, function, and diversity of plants with an emphasis on seed plants. The physiology, morphology, and taxonomy of plants is emphasized.
Max Credits: 3
Min Credits: 3

81.322 Botany Laboratory
81.324 Economic Botany

Course ID: 38098

Course Details: Discussions on how humans use plants. Topics will include: Structure and characteristics of woods and their uses in construction of various items, agricultural uses of food plants and spices, poisonous plants, medicinal plants, plants used in religious ritual and plants used as hallucinogens, plants that have altered human history.

Max Credits: 3
Min Credits: 3

81.335 Principles of Genetics

Course ID: 7498

Course Details: The theories of both classical and molecular genetics are explored with emphasis on the experimental evidence which has laid the foundation for contemporary understanding of genetics. Included is the nature of the genetic material, gene action, genetic recombination, gene regulation, gene interaction, the production and inheritance of genetic phenotypes, chromosomal mechanics, and the behavior of genes in populations.

Max Credits: 3
Min Credits: 3

81.337 Experimental Genetics

Course ID: 7499

Course Details: Techniques of genetic analysis using molecular, prokaryotic and eukaryotic systems. There is an emphasis on problem solving and statistical methods.

Max Credits: 1
Min Credits: 1

81.401 Supervised Teaching Biology I

Course ID: 7508

Course Details: Through observation, preparation of material and presentation of demonstrations in selected courses offered by the Department of Biological Sciences, the student becomes familiar with the materials and teaching/learning situations in biology.

Max Credits: 1
Min Credits: 1

81.402 Supervised Teaching Biology II

Course ID: 7509

Course Details: Through observation, preparation of material and presentation of demonstrations in selected courses offered by the Department of Biological Sciences, the student becomes familiar with the materials and teaching/learning situations in biology.

Max Credits: 1
Min Credits: 1

81.409 Photobiology

Course ID: 36853

Course Details: Biological process involving light in plants and animals. Topics include mechanisms of light absorption, energy
transduction, light reactions in photosynthesis, functions of color in flowering plants, visual systems and structural and pigment coloration in animals, pigmentation in animals affecting camouflage and reproductive strategies. In addition, the genetics involved in responses to light such as photoperiods, circadian rhythms, and seasonal cycles will be covered.

Max Credits: 3
Min Credits: 3

81.411 Senior Research Biology

Course ID: 7512

Course Details: An individual, directed one-year research program for senior biology majors selected on the basis of previous academic performance at the end of the junior year. A topic will be chosen after consultation with a faculty member. A report of the research in the form of a thesis is required.

Max Credits: 4
Min Credits: 4

81.412 Senior Research: Biology

Course ID: 7513

Course Details: An individual, directed one-year research program for senior biology majors selected on the basis of previous academic performance at the end of the junior year. A topic will be chosen after consultation with a faculty member. A report of the research in the form of a thesis is required.

Max Credits: 4
Min Credits: 4

81.413 Invertebrate Zoology II

Course ID: 35512

Course Details: An in depth exploration of the deuterostome phyla with a focus on anatomy, ecology and evolution of the lophophorates, Echinodermata, Chaetognatha, Hemichordata and Chordata. Includes readings from the primary literature.

Max Credits: 3
Min Credits: 3

81.415 Invertebrate Zoology Lab II

Course ID: 35513

Course Details: The laboratory study of live and preserved specimens of invertebrate animals with a focus on anatomy and functional morphology.

Max Credits: 1
Min Credits: 1

81.416 Climate Change: Science, Communication, and Solutions

Course ID: 36711

Course Details: Climate change offers one of the greatest challenges yet faced by society and scientists. The scientific consensus is clear that climate change is occurring, its pace is accelerating, its impacts on human society will be largely negative, and it is largely caused by anthropogenic greenhouse gas emissions. Yet, despite strong scientific evidence for the enormous challenges that society may face, scientists' attempts to disseminate that evidence beyond their peers have not yet been successful. Indeed in today's media world of blogs, YouTube video clips, and sound-bites, confusion over the scientific reality of climate change frequently dominates the discourse in classrooms and communities. This course will provide students with the tools and knowledge that they need to develop their own well-informed view of climate change. Because climate change is both impacted by humans and will increasingly impact society, this course takes a cross-disciplinary approach, integrating science, policy solutions, and media literacy as they relate to climate change.

Max Credits: 4
Min Credits: 4
81.419 Biochemistry

Course ID: 1235

Course Details: Studies the structure and properties of proteins, carbohydrates, and lipids which combined with a discussion of elementary enzymology allows for detailed descriptions of several important degradative and biosynthetic pathways, their integration and regulation. Throughout the course, emphasis is on methods and practical application of fundamental information to the solution of problems of current biomedical interest.

Max Credits: 3
Min Credits: 3

81.421 Biochemistry Techniques

Course ID: 7515

Course Details: A series of discussions and "hands on" laboratory exercises emphasizing techniques and use of equipment most commonly employed in biochemical-biomedical research laboratories. Techniques to be mastered include: cell culture, cell fractionation, enzyme purification, ultracentrifugation, UV-visible spectrophotometry, spectrofluorometry, various types of chromatography (thin layer, gas, gel exclusion, ion exchange), electrophoresis, liquid scintillation spectrometry, and the safe handling and application of radioisotopes to problems in biochemistry. Wherever possible, the principles presented in 81.419 will be used as a basis for experimentation using the above techniques.

Max Credits: 2
Min Credits: 2

81.423 Biology of Global Change

Course ID: 7517

Course Details: An examination of the role of life processes in controlling the cycling of elements on the surface of the Earth and atmosphere from the molecular to the global level. Students will learn how the different physical components of Earth interact, how these interactions are influenced by life, and how they affect Earth's habitability now and in the future.

Max Credits: 3
Min Credits: 3

81.426 Evolutionary Biology

Course ID: 36580

Course Details: Examines the patterns and processes of biological evolution that have led to the diversity of life. Topics covered include the history of evolutionary thought, the evidence for evolution, the generation and maintenance of population-level variation, natural selection, adaptation, sexual selection, speciation, phylogenetics, molecular evolution, the fossil record and extinctions. In addition to lecture and textbook material, students will read and discuss classic and contemporary primary literature from evolutionary biology.

Max Credits: 3
Min Credits: 3

81.428 Molecular Biotechnology: Recombinant Protein Production

Course ID: 37369

Course Details: Proteins are major targets of pharmaceuticals, and are themselves increasingly used as therapeutics. However both basic research and the pharmaceutical industry depends on availability of purified proteins that are often difficult to isolate from native sources. In this lecture course, students will learn basic and advanced theoretical background in expression and purification of recombinant proteins. It will cover a variety of expression systems including prokaryotic and eukaryotic cells. The course will also address traditional and new methods in recombinant protein purification. Furthermore, students will be introduced to some downstream applications such as crystallization screens and biochemical/biophysical studies.

Max Credits: 3
Min Credits: 3

81.432 Genomics
Course Details: This course surveys the field of genomics, examining current technologies and their biological applications. Lectures cover genome organization, genome sequencing and annotation, functional genomics, evolutionary genomics, transcriptomics, proteomics and the role of bioinformatics in organizing and interpreting genomic data.

Max Credits: 3
Min Credits: 3

81.434 Genomics Laboratory

Course Details: A series of molecular laboratory and computer-based bioinformatics exercises providing practical experience in the collection and analysis of genomic-level data.

Max Credits: 1
Min Credits: 1

81.437 Biology and Evolution of Arthropoda

Course Details: A detailed examination of phylum Arthropoda from developmental, ecological, genetic, morphological and paleontological perspectives. Specific topics include the relationships of arthropods to protoarthropod-like groups including tardigrades and onychophorans, the evolution of segmentation, and current perspectives on relationships within the phylum.

Max Credits: 3
Min Credits: 3

81.439 Biology and Evolution of Arthropoda Laboratory

Course Details: An exploration of protoarthropod and arthropod diversity using live and preserved specimens of the major taxa including Tardigrada, Onychophora, Chelicerata, Crustacea, Myriapoda and Hexapoda. Students will learn to collect, dissect, identify, handle and care for live specimens.

Max Credits: 1
Min Credits: 1

81.440 Advances in Plant Biology

Course Details: Examination of a range of topics in plant biology with an emphasis on processes that are unique to plants. The course will focus first on the role of plants in human affairs, and basic plant anatomy, physiology and genetics followed by three or more topics at an advanced level. Typical focus areas may include biosynthesis and regulation of fatty acids, metabolism of aromatic amino acids, studies of pathways leading to the synthesis of useful natural plant products and the genetic manipulation of plants to promote plant improvement.

Max Credits: 3
Min Credits: 3

81.442 Cell Biology

Course Details: Deals with the study of the cell and its cytoplasm incorporating the structure of cell membranes and the organelles they define; specialized organelles dealing with energy capture and transduction, some aspects of histochemical and biochemical studies on cytoplasmic organelles at the electron microscopic level. An introduction into cytogenetics and nuclear cytology; a brief discussion of prokaryotic cells.

Max Credits: 3
Min Credits: 3
81.451 Senior Seminar in Biology

Course ID: 7523

Course Details: This course instructs students in developing effective writing and speaking skills required for preparation of scientific manuscripts and presentations, and communicating in the scientific world. Students will be required to prepare and present oral presentations and to submit written reports.

Max Credits: 2
Min Credits: 2

81.452 Senior Seminar II

Course ID: 7524

Course Details: Seminar discussion of selected topics of current research interest. An oral seminar presentation as well as a written report are required of all biology seniors.

Max Credits: 1
Min Credits: 1

81.457 Advanced Invertebrate Zoology

Course ID: 33457

Course Details: Comparative functional morphology, life histories, and phylogeny of a particular taxon (Crustacea, Molusca) of invertebrates.

Max Credits: 3
Min Credits: 3

81.459 Advanced Invertebrate Zoology Laboratory

Course ID: 33458

Course Details: Classification, identification, anatomy and physiology of selected invertebrates.

Max Credits: 1
Min Credits: 1

81.460 Stem Cell Biology

Course ID: 33651

Course Details: The molecular and genetic characteristics of stem cells and their developmental potential will be explored. Lectures and readings will cover the development of embryonic, fetal and adult stem cells, and will examine their use in treating human disorders receiving widespread attention, including neurodegenerative diseases, heart disease, spinal cord injury and leukemia. The ethical, legal and social implications of stem cell research will also be discussed. Additional library investigation and a term paper or seminar will be required.

Max Credits: 3
Min Credits: 3

81.467 Molecular Biology

Course ID: 1234

Course Details: A study of the principles and specialized techniques of cloning, purifying, and manipulating recombinant DNA molecules.

Max Credits: 3
Min Credits: 3

81.472 Virology
Course ID: 7528
Course Details: A study of bacterial, animal, and plant viruses, including viral structure, modes of replication, biochemistry of the infected cell, genetic properties, and viral oncogenesis. Emphasis is on virus-cell interaction at the molecular level.
Max Credits: 3
Min Credits: 3

81.476 Cell Culture
Course ID: 1233
Course Details: A series of lecture and laboratory exercises that will focus on the in vitro culture and analysis of multiple cell type commonly used in biomedical research laboratories. The lecture component will review methodologies used to establish immortalized cell lines, medium component for specific cell types, and techniques for genetically manipulating and analyzing cell lines. The laboratory exercises will emphasize the mastery of sterile techniques used to grow both established cell line and primary cultures, and molecular tools used for introducing recombinant genes and for analyzing cell growth and differentiation.
Max Credits: 4
Min Credits: 4

81.482 Cancer Biology
Course ID: 33459
Course Details: A study of the genes and proteins implicated in the cause of human cancer and discussion of the complex behaviors of cancer cells that differ from their normal counterparts in human tissue. Lectures and original research papers will be used.
Max Credits: 3
Min Credits: 3

81.488 Structural Biology
Course ID: 37717
Course Details: Structural basis of the molecular biology of cells and the regulation of cellular processes will be discussed. This course will cover the fundamental knowledge about protein, nucleic acid and membrane structure in relation to central systems in biology. Topics to be discussed include structural enzymology, macromolecular assemblies for replication transcription, translation, membrane proteins, signal transduction, cell motility and transport, cell-cell interactions, the immune system, and virus structure.
Max Credits: 3
Min Credits: 3

81.489 Practical Protein Crystallography
Course ID: 38015
Course Details: This course provides grounding in the principles and practice of protein x-ray crystallography. The course will be unique in format and provide both didactic and laboratory instruction. It is comprised of a series of lecture and laboratory exercises, with an emphasis on practical techniques and hands-on experience of modern protein crystallography. The course will cover the fundamental knowledge about x-ray physics, instrumentation and geometrical diffraction, protein crystallization, macromolecular data collection and processing, phase estimation and improvement, model building and refinement, and model assessment. Student will also be given a recently published structural paper for writing a report on the subject.
Max Credits: 4
Min Credits: 4

81.490 Human Neurobiology
Course ID: 31890
Course Details: A study of cellular and systems neurobiology with a focus on how these relate to human health and disease. Particular attention will be given to illustrating functional neuroanatomy and neurophysiology of the human CNS using investigations into the pathogenic mechanisms of a variety of human neurodegenerative diseases including epilepsy, Alzheimer's Disease, Huntington's Disease, ALS among others. Note: Graduate level enrollees will be responsible for additional reading and writing.
Max Credits: 3
Min Credits: 3

81.491 Senior Project: Biology

Course ID: 7531

Course Details: Individual, directed one semester research project taken in the fall and/or spring. Presentation of an acceptable project plan at the time of registration is required. A project report is required.

Max Credits: 4
Min Credits: 4

81.492 Senior Project: Biology

Course ID: 7532

Course Details: Individual, directed one semester research project taken in the fall and/or spring. Presentation of an acceptable project plan at the time of registration is required. A project report is required.

Max Credits: 4
Min Credits: 4

81.493 Immunology

Course ID: 1231

Course Details: A study of the nature of the immune response with sections on antibody structure, function and production; antigen-antibody reactions; immunogenetics; and immune regulation, protection and injury.

Max Credits: 3
Min Credits: 3

81.495 Immunology Laboratory

Course ID: 1230

Course Details: A series of basic laboratory exercises dealing with the preparation, isolation and characterization of antigens, antibodies and effector cells.

Max Credits: 2
Min Credits: 2

81.496 Practicum Experience

Course ID: 7533

Course Details: On-campus and/or off-campus experiences are developed by the student in consultation with a member of the student's major department. Specific requirements will vary depending upon department policies and the nature of the program undertaken by the student. The intent of the practicum experience is to provide an occasion for investigation of a scientific area and for applying techniques of problem solving and/or skills which are appropriate to the student's major discipline. The practicum experience may not be substituted for a required course in the major.

Max Credits: 3
Min Credits: 3

81.498 Directed Study: Biology

Course ID: 33123

Course Details:

Max Credits: 2
Min Credits: 2
82.3CE Cooperative Education Work Experience I

Course ID: 37663

Course Details: This zero credit course is specifically designated for undergraduate students in the College of Sciences who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program and have secured their first, full-time co-op employment. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

82.4CE Cooperative Education Work Experience II

Course ID: 37802

Course Details: This zero credit course is specifically designed for undergraduate students from participating majors in the College of Sciences, who are participating in the voluntary co-op experience is designed to provide students the opportunity to develop and enhance their technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by their Co-op Coordinator.

Max Credits: 0
Min Credits: 0

82.210 Professional Development Seminar

Course ID: 36959

Course Details: The Professional Development Seminar is designed to provide students with the necessary structure, resources, and support to successfully secure and engage in their first cooperative education experience. Through a variety of teaching methodologies and assignments, students will participate in a sequence of learning activities including self-assessment, industry research, and the development of co-op learning objectives. Students will prepare to engage in the job search process through resume writing, strategic interviewing, professional networking and through learning professional behavior and presentation skills. The goal of the course is to assist each student in developing a sound plan of action to successfully participate in the cooperative education experience.

Max Credits: 1
Min Credits: 1

82.310 Co-op Assessment 1

Course ID: 36960

Course Details: The primary goal of this seminar is to assist students in the overall assessment of their overall cooperative education experience. Through facilitated small group discussion, individual consultation and hands on practice, students will have an opportunity to identify and articulate their technical and professional skills, and explore how these skills and their co-op employment might be translated and leveraged into future work environments and their academic program at UML.

Max Credits: 1
Min Credits: 1

82.410 Co-op Assessment 2

Course ID: 36961

Course Details: This seminar is designed to support and assist students in the continued assessment of their cooperative education experience. Through a deepening of their work in Co-op Assessment 1, students will review their overall performance in the cooperative education program, while continuing to demonstrate their technical and professional skills through written work and public presentations to multiple audiences. It is expected that students will clearly define their future academic and career goals, enhance their professional networks, and develop a future plan to support their engineering aspirations.

Max Credits: 1
Min Credits: 1
83.100 Introduction to Biology

Course ID: 7612

Course Details: Presents environmental and organismal structural interrelationships and relates these to the chemical evolutionary basis of life. Not suitable for credit towards any degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

83.101 Life Science I

Course ID: 7613

Course Details: Presents environmental and organismal structural interrelationships and relates these to the chemical evolutionary basis of life. Suitable as a Natural Science Elective for a degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

83.102 Life Science II

Course ID: 7614

Course Details: Emphasis is on systems structure and function. The cellular organization of plants and animals leads into physiological processes of higher organisms with great emphasis on humans. Among topics considered are nutrition and digestion, cellular metabolism, circulation, respiration, excretion, nervous and skeletal-muscular systems. Also considered are the chemical interactions of these systems with immunity, hormonal and reproductive processes. Suitable as a Natural Science Elective for a degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

83.103 Life Science I Laboratory

Course ID: 7615

Course Details: Concerned with experimentation and interpretation of some of the concepts of Life Science I. Suitable as a Natural Science Elective for a degree in the Division of Sciences.

Max Credits: 1
Min Credits: 1

83.104 Life Science II Laboratory

Course ID: 7616

Course Details: Involved with experimentation and interpretation of some of the concepts of Life Science II. Suitable as a Natural Science Elective for a degree in the Division of Sciences.

Max Credits: 1
Min Credits: 1

83.105 Introduction to Biology Lab

Course ID: 7617

Course Details: Introduction to Biology Laboratory is a co-requisite course for the Introduction to Biology online lecture course - 83.100. The two courses together fulfill a GenEd Science requirement. The lab course can be taken concurrently with the lecture course or subsequent to it. Weekly labs correspond directly with the chapter assignments provided by the 83.100 instructors.

Max Credits: 1
Min Credits: 1
83.110 Microbes and Society: Good, Bad and Ugly

Course ID: 35780

Course Details: Examines historical aspects of microbial interactions with human society, including the use of microbes in food production, agriculture, biotechnology, industry and environmental preservation; explores bioterrorism, the problem of antibiotic resistance and surveys some historical and contemporary microbial diseases.

Max Credits: 3
Min Credits: 3

83.123 Nutrition and Disease

Course ID: 7620

Course Details: Serves as an interdisciplinary survey course for students not majoring in biology, which deals with human nutrition as it relates to various chronic disease states. Methods of detection and treatment of the disorders are considered as well as general concepts of health promotion/disease prevention based on the Dietary Guidelines for Americans. Specific topics covered include the role of nutrition in: heart disease, diabetes, cancer, obesity, alcoholism, and eating disorders. Not suitable for credits toward any degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

83.125 Plants and Human Society

Course ID: 7621

Course Details: This course is designed primarily to fulfill the science elective requirement for the non-science major. Its purpose is to provide the undergraduate student who is not majoring in the biological sciences with an introduction to the study of plants and their importance in our everyday world. The importance of plants in agriculture, medicine and industry will be emphasized. Not suitable for credit towards any degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

83.127 Plants & Human Society Lab

Course ID: 30382

Course Details: Not suitable for credit towards any degree in the Division of Sciences.

Max Credits: 1
Min Credits: 1

83.214 Human Ecology

Course ID: 7626

Course Details: Designed to reveal and discuss the increasing problems of overpopulation in regard to environmental deterioration, living space, limits of natural resources and the adverse effects of human alteration on destruction of the natural ecosystem. The implications of current literature and news items will be emphasized. Not suitable for credit towards any degree in the Division of Sciences.

Max Credits: 3
Min Credits: 3

84.101 Applied Chemistry for Non-Scientists

Course ID: 7633

Course Details: Provides an understanding of basic chemical principles -- atomic structure, bonding and interparticle forces, physical and chemical properties of matter through hands-on examination of matter and the application of principles to understanding the chemistry of current issues (e.g., environmental chemistry, biochemistry, food and drug chemistry) and the analysis of problems dealing with these issues. This course is not available for credit for Science or Engineering majors.
84.102 Forensic Science for the Non-Scientist

Course Details: This course presents the inherently fascinating topics of crime and criminal investigations as a pathway for teaching the fundamental chemical concepts most often covered in an introductory non-majors course. This course capitalizes on the surge of interest in the scientific investigation of crime (as sparked by CSI and other television shows) and will collate the theme of forensic science with the fundamentals of chemistry. The course material will be continually updated with each offering.

Max Credits: 3
Min Credits: 3

84.105 Intro to the Discipline of Chemistry

Course Details: This course provides an introduction to chemistry as a career. Required of chemistry majors, it discusses historical aspects of the field and modern career paths, including academic and industrial chemistry. Students are presented with information regarding career opportunities in chemistry, including: analytical/environmental, forensics, inorganic, organic, materials, pharmaceutical/biochemistry, polymer, and theoretical/physical. They are also given an introduction to graduate school and teaching opportunities often pursued following the B.S. degree. In addition to lectures by the instructor, guests from industry and government laboratories are invited to discuss "what it means to be a chemist".

Max Credits: 1
Min Credits: 1

84.111 General Chemistry I

Course Details: Provides a one-semester survey of inorganic chemistry: the structure and properties of matter, chemical reactions, stoichiometry, gas laws, solution chemistry, kinetics, equilibrium, and acid-base chemistry.

Max Credits: 3
Min Credits: 3

84.112 General Chemistry II

Course Details: Surveys the basic principles of organic chemistry and biochemistry with emphasis on biochemical aspects of carbohydrates, lipids, proteins and nucleic acids. Various metabolic pathways are also emphasized.

Max Credits: 3
Min Credits: 3

84.113 General Chemistry Laboratory I

Course Details: Lab experiments designed to illustrate the principles covered in 84.111.

Max Credits: 1
Min Credits: 1

84.114 General Chemistry Laboratory II

Course Details: Uses laboratory experiments designed to illustrate the principles discussed in 84.112.

Max Credits: 1
84.117 Selected Topics in Chemistry

Course Details: A one semester general chemistry course for mechanical engineering students. The properties of matter, chemical bonding, stoichiometric relationships, energy and chemical thermodynamics, kinetics, chemical equilibrium, electrochemistry and nuclear chemistry are the major areas discussed. Relationships among chemistry, material science and engineering are central to the course. Problem solving is emphasized.

Max Credits: 3
Min Credits: 3

84.121 Chemistry I

Course Details: Provides an introduction to the basic concepts of chemistry through classroom discussions and demonstrations. Topics include chemical calculations, atomic structures, the periodic table, basic bonding theory, solutions, liquids, and gases. Restricted to science, engineering, and engineering technology majors.

Max Credits: 3
Min Credits: 3

84.122 Chemistry II

Course Details: Serves as a continuation of 84.121. Topics include thermodynamics; kinetics, acids and bases; an introduction to organic chemistry; chemical equilibrium; precipitation reactions; and electrochemistry. Restricted to science, engineering, and engineering technology majors.

Max Credits: 3
Min Credits: 3

84.123 Chemistry I Laboratory

Course Details: Studies experimental chemical principles and chemical transformation that is coordinated with topics considered in 84.121. Some of the more important reactions of elements, oxides, acids, bases, and salts are examined. Other topics include chemical separation, purification, preparation of inorganic salts, quantitative determinations dealing with the formula of a compound, gas laws, and colligative properties. Careful techniques and precise measurements are stressed. Restricted to science, engineering, and engineering technology majors.

Max Credits: 1
Min Credits: 1

84.124 Chemistry II Laboratory

Course Details: Serves as a continuation of the laboratory study begun in 84.123 that is coordinated with topics of 84.122. Topics include: thermochemistry, kinetics, spectroscopy, titration, pH, equilibrium reaction and constants. Some aqueous solution reactions and organic reactions are examined. Accurate measurements and precise instrumental and apparatus operation are expected. Restricted to science, engineering, and engineering technology majors.

Max Credits: 1
Min Credits: 1

84.135 Honors Chemistry I

Course Details:
Course Details: A more in-depth view of the topics covered in Chemistry I (84.121). Topics include chemical reactions and calculations, atomic history and structures, the behavior of gases and bonding theory. Open to students enrolled in the Honors Program, and may be taken instead of 84.121.

Max Credits: 3
Min Credits: 3

84.136 Honors Chemistry II

Course ID: 7644

Course Details: A continuation of 84.135. A more in-depth view of the topics covered in Chemistry II (84.122). Topics include solutions, kinetics, thermodynamics, acids and bases, chemical equilibrium, electrochemistry and solubility. Open to students enrolled in the Honors Program, and may be taken instead of 84.122.

Max Credits: 3
Min Credits: 3

84.204 Introduction to Organic and Polymer Chemistry

Course ID: 7650

Course Details: This course is a one-semester overview of organic chemistry for plastics engineering majors. Organic chemistry and its associated principles underscore a broad component of the plastics engineering curriculum. It is desirable therefore for such students to develop a basic appreciation of the fundamental reactions in organic chemistry, as well as an understanding of the interaction of organic compounds with their environment. Students will therefore be expected to secure a basic understanding of, e.g., chemical bonding, the chemistry of alkanes, alkenes, alkynes, aromatic compounds, substitution and elimination reactions, reactions of organic alcohols, ethers, epoxides, aldehydes and ketones, carboxylic acids, and amine compounds. When appropriate, examples will be provided that relate to those typical polymerization reactions (e.g. free-radical or ionic) employed to manufacture commercial polymer materials. Coverage will include synthesis of organic chemicals and polymers from natural and sustainable materials.

Max Credits: 3
Min Credits: 3

84.205 Principles Of Organic Chemistry Laboratory

Course ID: 7651

Course Details: Introduction to the basic skills and techniques used in the synthesis, purification, and characterization of representative organic compounds. Open to Plastics Engineering students in the fall semester and Chemical Engineering students in the spring semester.

Max Credits: 1
Min Credits: 1

84.221 Organic Chemistry IIA

Course ID: 7655

Course Details: Studies the basic principles and reactions which characterize the chemical behavior of carbon compounds. Nomenclature, reactions, reaction mechanisms, and stereochemistry will be covered. Required for chemistry majors.

Max Credits: 3
Min Credits: 3

84.222 Organic Chemistry IIA

Course ID: 7656

Course Details: A continuation of 84.221 including an introduction to infrared and NMR spectroscopy and biochemistry. The application of organic reactions in multi-step synthesis is stressed.

Max Credits: 3
Min Credits: 3
84.227 Organic Chemistry Laboratory I

Course ID: 7661

Course Details: Laboratory work designed to emphasize the techniques of organic synthesis and the use of instrumentation for identification and characterization of organic compounds. Required for chemistry majors.

Max Credits: 2
Min Credits: 2

84.228 Organic Chemistry Laboratory II

Course ID: 7662

Course Details: A continuation of 84.227 including an introduction to semimicro organic techniques. Planning and successfully carrying out reactions published in the chemical literature are emphasized. Required for chemistry majors.

Max Credits: 2
Min Credits: 2

84.229 Organic Chemistry Laboratory IA

Course ID: 7663

Course Details: Reviews techniques, skills, and heuristic approaches in the synthesis, purification, and identification of organic compounds. IR, GC, and NMR instrumental methods are included.

Max Credits: 1
Min Credits: 1

84.230 Organic Chemistry II A Lab

Course ID: 7664

Course Details: A continuation of 84.229.

Max Credits: 1
Min Credits: 1

84.260 Information Retrieval

Course ID: 7665

Course Details: An introduction to the important chemical and chemical-related reference sources including journals, patents, technical publications, and compiled reference works, and instructions in their use. Assignments require the use of each source discussed. Online searching using computerized chemical and chemical related databases is also introduced.

Max Credits: 2
Min Credits: 2

84.301 Special Topics: Chemistry

Course ID: 7667

Course Details:

Max Credits: 3
Min Credits: 3

84.303 Forensic Science I

Course ID: 35812

Course Details: Introduction to Forensic Science, Fundamental statistics, Data Sampling & Quality Multivariate statistics, calibration and
quality, Partitioning, thin-layer chromatography, Immunoassay, Instruments, Introduction to drug and pharmacology.

Max Credits: 3
Min Credits: 3

84.304 Forensic Science II

Course ID: 35813

Course Details: Drug Analysis I, Drug Analysis II, Chemistry of combustion and Arson, Chemistry of color and colorants, Analysis of ink and paints, Chemistry of polymers, Analysis of fibers and papers.

Max Credits: 3
Min Credits: 3

84.305 Forensic Science I Laboratory

Course ID: 35814

Course Details: Locard's exchange principle, Reagent preparation, crime scene investigation, a case of deductive reasoning, crime scene sketching, Forensic glass analysis, Fingerprint, Introduction to Microscopy, Color perception.

Max Credits: 1
Min Credits: 1

84.306 Forensic Science II Laboratory

Course ID: 35815

Course Details: Forensic hair analysis, Handwriting comparison, Fluorescence detection of drug, Introduction to Immunoassay and enzyme catalysis, Fluorescence microscopy Analysis of gunshot residues, Analysis of metal, Analysis of flammable.

Max Credits: 1
Min Credits: 1

84.313 Analytical Chemistry I

Course ID: 7668

Course Details: Focuses on the evaluation of analytical data, aqueous and non-aqueous acid-base systems, oxidation reduction and complexation equilibria, solubility and precipitation, solvent extraction, ion-exchange and chromatographic methods.

Max Credits: 3
Min Credits: 3

84.314 Analytical Chemistry II

Course ID: 7669

Course Details: Introduces modern instrumental methods of chemical analysis. Topics to be discussed include ultraviolet, infrared nuclear magnetic resonance, emission and atomic absorption spectroscopy. Mass spectrometry, chromatography, thermal and electrochemical methods of analysis will also be covered.

Max Credits: 3
Min Credits: 3

84.315 Analytical Chemistry Laboratory I

Course ID: 7670

Course Details: Experiments emphasizing the topics presented in 84.313 are conducted.

Max Credits: 2
Min Credits: 2
84.316 Analytical Chemistry Laboratory II

Course ID: 7671
Course Details: Presents laboratory experiments designed to complement the coverage of topics in 84.314.
Max Credits: 2
Min Credits: 2

84.339 Physical Chemistry Principles

Course ID: 7676
Course Details: A one-semester course designed for plastics engineering majors. Physical chemical concepts of importance to plastics and polymeric materials are emphasized and include kinetics, spectroscopy, phase rule, and statistical thermodynamics.
Max Credits: 2
Min Credits: 2

84.344 Physical Chemistry I

Course ID: 7678
Course Details: Covers basic physical chemical topics: laws of thermodynamics, solutions, chemical and phase equilibria, electrochemistry, kinetics, atomic, and molecular structure.
Max Credits: 3
Min Credits: 3

84.345 Physical Chemistry II

Course ID: 7679
Course Details: Serves as a continuation of 84.344.
Max Credits: 3
Min Credits: 3

84.346 Physical Chemistry Laboratory I

Course ID: 7680
Course Details: Laboratory work designed to exemplify principles covered in 84.344. Required for chemistry majors.
Max Credits: 2
Min Credits: 2

84.347 Physical Chemistry Laboratory II

Course ID: 7681
Course Details: Provides laboratory work designed to exemplify the principles of chemical kinetics, equilibrium, and spectroscopy.
Max Credits: 1
Min Credits: 1

84.350 Physical Bioinorganic Laboratory

Course ID: 7682
Course Details: Coordination compounds are utilized in a core of experiments to illustrate basic physiochemical techniques and analysis of experimental data in electrochemistry and kinetics. A project lab is carried out to apply and extend techniques learned.
Max Credits: 2
Min Credits: 2

84.407 Undergraduate Thesis

Course ID: 7689
Course Details: Research in biochemistry, electrochemistry or analytical, organic, inorganic, physical or polymer chemistry. Progress report required.
Max Credits: 3
Min Credits: 3

84.408 Undergraduate Thesis II

Course ID: 7690
Course Details: A continuation of 84.407. Both semesters must be taken and not more than six credits may be used in meeting degree requirements. A written thesis and seminar are required. The written thesis is to follow the conventional form of introduction, literature survey, data, results, and conclusions. One copy of the thesis must be filed in the Department office.
Max Credits: 3
Min Credits: 3

84.443 Advanced Inorganic Chemistry

Course ID: 30385
Course Details: The chemical behavior, structure and methods of preparation and nomenclature of the more common elements and their compounds.
Max Credits: 3
Min Credits: 3

84.445 Advanced Inorganic Lab

Course ID: 30386
Course Details: Laboratory to study the reactions of ions in aqueous solutions and to carry out inorganic syntheses and characterizations.
Max Credits: 2
Min Credits: 2

84.450 Introduction To Biochemistry

Course ID: 7692
Course Details: An introductory study of the fundamental principles of biochemistry including the chemistry of proteins, carbohydrates, nucleic acids and lipids, thermodynamics, kinetics and mechanisms of enzyme action, intermediary metabolism and selected topics in molecular biology.
Max Credits: 3
Min Credits: 3

85.102 Weather Forecasting Seminar

Course ID: 7764
Course Details: Introduction to forecasting techniques including use of upper air observations and numerical forecast guidance. This course is intended primarily for students majoring in the various options of environmental science. It does not satisfy specific science requirements for majors in the Division of Science.
Max Credits: 1
Min Credits: 1
85.120 The Nature of Science

Course ID: 7765

Course Details: In this course students are introduced to the role of critical thinking in the development of scientific theories. Several major areas of science are explored with a focus on the link between conceptual thought and the resulting physical laws. The importance to society of scientists and citizens making informed decisions on science/technology issues are examined. Methods to gather and assess data are discussed and a number of examples of the use of scientific principles to prove fact or fraud are studied. The students will learn how to question propositions put before them.

Max Credits: 3
Min Credits: 3

85.141 Weather and Climate

Course ID: 7766

Course Details: Serves as a general meteorology course for the non-science major. Topics include: atmospheric composition, solar radiation, temperature, moisture and condensation relationship between air pressure and wind, weather patterns, severe weather, optical phenomena in the atmosphere, and the behavior and possible change of climate. This course satisfies the Gen Ed science requirement, but not specific science requirements for majors in the Division of Science.

Max Credits: 3
Min Credits: 3

85.143 Weather and Climate Laboratory

Course ID: 7767

Course Details: The laboratory encourages students to apply knowledge from the lectures to a variety of atmospheric and climatic phenomena developed from data analysis, experimentation, and maps. Synthesis and critical thinking are encouraged in the solution of problems.

Max Credits: 1
Min Credits: 1

85.213 Atmospheric Science Laboratory

Course ID: 7770

Course Details: The plotting and analysis of meteorological data is introduced, with the goal of understanding the basis for various ways of looking at weather systems. After each technique is introduced, students will see the computer counterpart using the workstations in the weather lab. Both the strengths and weaknesses of automated displays are made clear to students, thus making them better able to interpret the computer images on a daily basis.

Max Credits: 1
Min Credits: 1

85.214 Meteorology Analysis Laboratory

Course ID: 7771

Course Details: The use of the skew-T diagram to understand the vertical structure in the atmosphere is the main focus of this course. Students will learn to plot and analyze atmospheric sounding data, and to recognize various structures in the analyzed data. Both hand and computer-aided analysis will be compared.

Max Credits: 1
Min Credits: 1

85.234 Scientific FORTRAN Programming

Course ID: 7772

Course Details: A basic course in computer programming using FORTRAN 90/95. Topics include programming arithmetic, decisions, repetition, input/output structures, arrays and array processing, and simple algorithms for searching and sorting.
Max Credits: 3
Min Credits: 3

85.291 Practicum in Meteorology

Course ID: 7773
Course Details:
Max Credits: 3
Min Credits: 3

85.301 Atmospheric Dynamics

Course ID: 7774
Max Credits: 3
Min Credits: 3

85.304 Methods in Meteorology I

Course ID: 7776
Course Details: The application of vector analysis to dynamic meteorology. Three-dimensional divergence and vorticity, circulation, and solenoids. Selected ordinary and partial differential equations of fluid mechanics and their solutions. Spectral decomposition of hemispheric wave motion.
Max Credits: 3
Min Credits: 3

85.305 Methods in Meteorology II

Course ID: 7777
Course Details: Fundamentals of numerical weather prediction. Data analysis methods in meteorology using the techniques of curve fitting, correlation, and power spectrum analysis. Solution of stability problems.
Max Credits: 3
Min Credits: 3

85.308 Forecasting and Synoptic Techniques I

Course ID: 7779
Course Details: Explores techniques of synoptic analysis including graphical subtraction, thickness analysis, isentropic analysis, streamlines and trajectories, divergence and vorticity. The use of a computer to perform these computations is explored through student projects.
Max Credits: 3
Min Credits: 3

85.309 Forecasting and Synoptic Techniques II

Course ID: 7780
Course Details: Explores three-dimensional structure and dynamics of mid-latitude storm systems; capabilities and limitations of the barotropic model; quasi-geostrophic model; and operational primitive equation models. Some mesoscale phenomena are covered as time permits including coastal cyclogenesis, thermal lows, and sea-breeze circulations.
Max Credits: 3
Min Credits: 3

85.313 Physical Climatology

Course ID: 7781
Course Details: Atmospheric processes determining the climate: solar and terrestrial radiation, elevation and thermal properties of surfaces, atmospheric circulations and eddy conduction between the atmosphere and land or sea surfaces, heat and water balance of earth’s surface and the atmosphere; hydrologic cycle; and climatic simulation models.
Max Credits: 3
Min Credits: 3

85.340 Tropical Meteorology

Course ID: 7782
Course Details: An introduction to the tropical atmosphere including tropical climatology, structure and dynamics of easterly waves, tropical cyclones and monsoonal circulations.
Max Credits: 3
Min Credits: 3

85.350 Satellite and Radar Meteorology

Course ID: 7783
Course Details: Explores theory and applications of radar, satellites, and lidar. Use of satellite imagery as a forecasting aide, theory and use of satellite profiling, and application of conventional and Doppler radar to severe weather and short term forecasting. Use of lidar and other profiling techniques to determine vertical temperature structure and turbulence.
Max Credits: 3
Min Credits: 3

85.403 Physical Meteorology

Course ID: 7785
Course Details: Explores solar and terrestrial radiation processes and the heat balance of the atmosphere; fundamentals of radiation theory; radiative transfer processes in the atmosphere; atmospheric condensation processes; and nucleation theory and the growth of water drops and ice crystals by condensation, sublimation and accretion.
Max Credits: 3
Min Credits: 3

85.410 Advanced Forecasting

Course ID: 7786
Course Details: Advanced analysis techniques and their use as forecasting tools are explored in both manual and computer formats. Techniques include moisture advection, moist isentropic trajectories, boundary layer destabilization, and other state-of-the-art techniques. Application of techniques to small and mesoscale phenomena.
Max Credits: 3
Min Credits: 3

85.415 Advanced Atmospheric Dynamics I

Course ID: 7788
Max Credits: 3
Min Credits: 3

85.416 Advanced Atmospheric Dynamics II

Course ID: 7789


Max Credits: 3
Min Credits: 3

85.420 Introduction to Operational Numerical Weather Prediction

Course ID: 36535

Course Details: In this class, the student will learn the structure and science behind modern numerical weather prediction models and how to use them to solve real-world issues facing modern meteorological consultants. The student will learn how to operate and apply a modern numerical weather prediction model to study such issues as offshore wind farm siting, solar power prediction, and energy load forecasting. Students should be prepared to use Linux-based PC's (supplied) to perform and submit projects.

Max Credits: 3
Min Credits: 3

85.471 Air Pollution

Course ID: 7791

Course Details:

Max Credits: 3
Min Credits: 3

85.484 Space Weather

Course ID: 35075

Course Details: Space Weather is an emerging field of space science focusing on understanding the conditions and processes on the sun, in the interplanetary space, and in the Earth's magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. This course is an introduction level course. It applies knowledge learned in Physics I and II in particular in electromagnetics to a real situation: space. The course introduces the present knowledge of space phenomena and the physical understanding of the plasma environment from the sun to the earth's ionosphere and in the heliosphere. Regions in space to be discussed include solar surface, solar wind, bow shock, magnetopause, magnetosphere, magnetotail, radiation belts, ring currents, and ionosphere. Among space plasma physics theories, single particle theory, kinetic theory, and magnetohydrodynamics, which describe charged particle motion in electromagnetic fields and its consequences, are introduced and applied to space environment.

Max Credits: 3
Min Credits: 3

85.491 Directed Study

Course ID: 7793

Course Details: Students, through regular and frequent consultation with the instructor, undertake independent study of a particular area of meteorology.

Max Credits: 3
Min Credits: 1

85.495 Honors Research in Atmospheric Science
Course ID: 7794
Course Details: An individual or team research project carried out by qualified students with the approval of and supervision by a faculty member.
Max Credits: 3
Min Credits: 3

85.496 Practicum Experience in Meteorology

Course ID: 7795
Course Details: A program of on-campus and/or off-campus experiences developed by the student in consultation with a faculty member and, when appropriate, a member of the staff of an off-campus firm. May be repeated up to a maximum of six credits. The practicum may not be substituted for a nonelective course in the major.
Max Credits: 3
Min Credits: 1

87.101 Environmental Science Seminar

Course ID: 7840
Course Details: A survey of the field of environmental science, curriculum options, and career opportunities. Presentations by members of the department and guest speakers. This course is intended primarily for students majoring in the various options of environmental science. It does not satisfy specific science requirements for majors in the Division of Science.
Max Credits: 1
Min Credits: 1

87.102 Environmental Problems Seminar

Course ID: 7841
Course Details: A survey of environmental problems and issues. Topics include air, water, and noise pollution; solid and liquid waste disposal; and the social, political, and economic implications of these issues. Readings, discussions, guest speakers, and field trips. This course is intended primarily for students majoring in the various options of environmental science. It does not satisfy specific science requirements for majors in the Division of Science.
Max Credits: 1
Min Credits: 1

87.115 Astronomy

Course ID: 7847
Course Details: Offers an introduction to the study of astronomy including historical development, instruments, solar system dynamics, planetary evolution, stellar systems and stellar evolution. Several field trips are included. This course satisfies the Gen Ed science requirement, but not specific science requirements for majors in the Division of Science.
Max Credits: 3
Min Credits: 3

87.117 Astronomy Lab

Course ID: 7848
Course Details: Intended to develop a deeper understanding of astronomy through an exposure to the methods and materials used in astronomical analysis. Corequisite: 87.115 I II(0,2)1
Max Credits: 1
Min Credits: 1

87.201 Earth and Environmental Systems I
Course ID: 7850

Course Details: An integrated study of the interactions between the lithosphere, hydrosphere, atmosphere, and biosphere. Emphasis will be placed on the physical and biological principles which underlie and control these interactions, pollution, geologic hazards, climate change, and social and political aspects which govern our relationship with the natural environment.

Max Credits: 3
Min Credits: 3

87.202 Earth And Environmental Systems II

Course ID: 7851

Course Details: A continuation of Principles of Earth & Environmental Systems.

Max Credits: 3
Min Credits: 3

87.203 Earth And Environmental Systems Laboratory

Course ID: 7852

Course Details:

Max Credits: 1
Min Credits: 1

87.204 Earth And Environmental Systems Laboratory

Course ID: 7853

Course Details:

Max Credits: 1
Min Credits: 1

87.301 GIS in Earth and Environmental Sciences

Course ID: 37132

Course Details: This course introduces earth and environmental science students to applications of geographic information systems, emphasizing hands-on field experience in collecting spatial location data and in mapping environmental data using GIS software. Covers fundamentals of: geodesy; spherical and plane coordinate systems; spatial data concepts, including error, accuracy, and precision; location measurement technologies including GPS; vector and raster GIS data structures and file types, basic GIS operations, including georeferencing of raster files and editing of vector files; assembly of field data over a base map; analysis of spatial relationships using GIS tools; symbology and methods of map presentation.

Max Credits: 3
Min Credits: 3

87.496 Practicum

Course ID: 7866

Course Details: A program of on-campus and/or off-campus experiences developed by the student in consultation with a faculty member from the Department and, when appropriate, a member of the staff of an off-campus firm. May be repeated to a maximum of six credits. The practicum may not be substituted for a required course in the major.

Max Credits: 3
Min Credits: 1

89.101 General Geology

Course ID: 7881
Course Details: Presents a study of the earth with emphasis on earth materials, earth structure (crustal and internal), earth history, and the development of life. Designed for the general student.

Max Credits: 3
Min Credits: 3

89.103 General Geology Laboratory

Course ID: 7883

Course Details: Topics covered include rock and mineral identification; interpretation of topographic and geologic maps; earthquakes and rock deformation; ground water, streams, wind, and glaciers and the sculpting of the Earth's surface; and natural hazards and their impacts to humans.

Max Credits: 1
Min Credits: 1

89.151 Earth and Life

Course ID: 7891

Course Details: This course will trace the changes in both the Earth and a variety of organisms through an investigation of fossils, field sites, map interpretation, and basic earth science principles. The effects of physical change and geobiochemical processes on evolution will be stressed as will the effects of life on Earth. Students will gain an appreciation of the very special nature of the earth and its symbiont life forms when seen against the background of other planets.

Max Credits: 3
Min Credits: 3

89.153 Earth and Life Laboratory

Course ID: 7892

Course Details: This laboratory will concentrate on the identification of fossils, discrimination of fossils from sedimentary structures, and interpretation of ancient environments from lithology, fossils, and maps. A field trip is required.

Max Credits: 1
Min Credits: 1

89.215 Forensic Geology

Course ID: 30952

Course Details: This course deals with the application of geological and related principles to the solution of various types of crimes. The course will explore the use of evidence (rocks and minerals, soils, geochemistry, etc.) to identify the source and hence the potential perpetrator of the crime.

Max Credits: 3
Min Credits: 3

89.301 Mineralogy and Crystallography

Course ID: 7903

Course Details: This course will introduce the concepts of crystallography necessary to prepare the student to use the analytical equipment of Optical Mineralogy and X-ray Crystallography. It also contains topics on the physical properties and chemistry of minerals aimed at improving the student’s ability to identify mineral samples. A significant portion of the course will be devoted to an introduction to optical methods using oil immersion and thin section techniques.

Max Credits: 3
Min Credits: 3

89.303 Mineralogy And Crystallography Laboratory

Course ID: 7904
Course Details: Techniques of crystallographic description. Megaoscopic and microscopic techniques of mineral identification.

Max Credits: 1
Min Credits: 1

**89.304 Igneous & Metamorphic Petrology**

Course ID: 7905

Course Details: The origin and evolution of igneous and metamorphic rocks. Emphasis will be on physical and chemical processes, magma transport and crystallization, phase equilibria, development of metamorphic facies, open and closed system behavior, and the development of metamorphic fabric.

Max Credits: 3
Min Credits: 3

**89.306 Igneous and Metamorphic Petrology Laboratory**

Course ID: 7906

Course Details: Identification and classification of igneous and metamorphic rocks. Emphasis is on thin section identification and use of rock textures and compositions as guides to petrogenesis.

Max Credits: 1
Min Credits: 1

**89.314 Hydrogeology**

Course ID: 7907

Course Details: This course investigates the science of water in a geologic setting with special emphasis on the distribution, movement, and chemistry of the water. The course will include the following topics: techniques for measuring elements in the hydrologic equation, accuracy of hydrologic measurement, statistical studies of floods, and study of groundwater for both steady-state and transient conditions.

Max Credits: 3
Min Credits: 3

**89.315 Environmental Geochemistry**

Course ID: 7908

Course Details: Application of geochemical principles to environmental problems including air pollution and atmospheric processes, climate change, water chemistry and water-rock interactions, and the transport and dispersal of organic and inorganic pollutants.

Max Credits: 4
Min Credits: 4

**89.316 Geomorphology**

Course ID: 7909

Course Details: A study of the physical and chemical processes at work on the earth's surface which result in the formation and development of surface features. Emphasis is placed on the mechanics of erosion (water, wind, ice, and waves) and the morphology and spatial distribution of the resultant landforms.

Max Credits: 3
Min Credits: 3

**89.318 Geomorphology Laboratory**

Course ID: 7910

Course Details: Investigates landforms and surficial processes through an interpretation of maps and field work. Environmental
applications of surficial processes are stressed.

Max Credits: 1
Min Credits: 1

89.322 Structural Geology

Course ID: 7911

Course Details: An analysis of crustal deformation through detailed study of geologic structures with emphasis upon the response of geologic materials to stress and strain. Field techniques, tectonic principles, and geometrical analysis are employed.

Max Credits: 3
Min Credits: 3

89.324 Structural Geology Laboratory

Course ID: 7912

Course Details: A survey of the graphical techniques used to convert field measurement into the information needed in the construction of geologic maps, cross-sections, and crustal stress-strain histories.

Max Credits: 1
Min Credits: 1

89.352 Sedimentation And Stratigraphy

Course ID: 7915

Course Details: Principles and processes of sedimentation: erosion, mechanics of transport, diagenesis and lithification, models for sedimentary environments. Development of the stratigraphic record, relative and absolute time, and seismic stratigraphy.

Max Credits: 3
Min Credits: 3

89.354 Sedimentation And Stratigraphy Laboratory

Course ID: 7916

Course Details: Determination of mass properties of sediments with emphasis on mechanical and statistical analysis, identification and description of sedimentary rocks, facies models and stratigraphic cross-sections.

Max Credits: 1
Min Credits: 1

89.456 Applied Geophysics

Course ID: 7920

Course Details: Application of geophysics to problems in geology and environmental science. Principles and techniques of gravity, magnetic, electrical, and seismic methods. Field projects and surveys.

Max Credits: 3
Min Credits: 3

89.495 Honors Research Geology

Course ID: 7922

Course Details: An independent scientific research project carried out by a qualified senior under the supervision of a faculty member.

Max Credits: 3
Min Credits: 1
**91.100 Media Computing**

Course ID: 8054

Course Details: Introduction to computer programming using multimedia applications. Programming data structures are covered by manipulating pictures, sounds and video. Linear Data structures such as arrays and matrices are manipulated in a computer programming language Java and C.

Max Credits: 3

Min Credits: 3

**91.101 Computing I**

Course ID: 8055

Course Details: Introduction to computing environments: introduction to an integrated development environment; C, C++, or a similar language. Linear data structures; arrays, records, and linked lists. Abstract data types, stacks, and queues. Simple sorting via exchange, selection, and insertion, Basic file I/O. Programming style documentation and testing. Ethical and social issues. Effective Fall 2013, Co-req 91.103 Computing 1 Lab.

Max Credits: 3

Min Credits: 3

**91.102 Computing II**

Course ID: 8056


Max Credits: 3

Min Credits: 3

**91.112 Undeclared Science Seminar**

Course ID: 36238

Course Details: Discussions will be conducted on a wide range of topics in the sciences to familiarize the student with the programs, procedures, research, and educational opportunities at the University.

Max Credits: 1

Min Credits: 1

**91.113 Exploring the Internet**

Course ID: 8058

Course Details: This course focuses on the primary tools used to navigate the Internet from a Windows desktop: e-mail and the web browsers. In addition, this course covers many of the other applications of the Internet: ftp, listserv, newsgroups, chat, search engines, and portals. Students will complete hands-on exercises, including construction of their personal web page. Not for computer science majors.

Max Credits: 3

Min Credits: 3

**91.117 Artbotics**

Course ID: 33571

Course Details: Artbotics focuses on exploring the intersection among art, computer science, and robotics. The course is project-driven, and includes public exhibitions and service learning. Students will learn founding principles in both the fields of art and computer science, and put them into practice by creating interactive, tangible exhibits that are displayed in public settings. In the service learning component, students will mentor local high school students in the same topics. The course will also include guest lectures from practitioners in the fields.
Max Credits: 4
Min Credits: 4

91.201 Computing III

Course ID: 8064


Max Credits: 4
Min Credits: 4

91.203 Assembly Language Programming

Course ID: 8066

Course Details: Presents the organization and operation of a conventional computer, including principal instruction types, data representation, addressing modes, program control, I/O, assembly language programming, including instruction mnemonics, symbolic addresses, assembler directives, system calls, and macros, the usage of text editors, symbolic debuggers, and loaders, and the use of pseudocode in guiding structured assembly language programming.

Max Credits: 4
Min Credits: 4

91.204 Computing IV

Course ID: 8067


Max Credits: 3
Min Credits: 3

91.211 Computer Science for SRT Applications

Course ID: 8069

Course Details: This course is an introduction to C programming, with applications in sound recording technology. Students will write and execute several programs that perform operations pertinent to SRT, including manipulating MIDI codes, performing simple signal processing functions, processing sampled data, and synthesizing sound algorithmically. Not for computer science majors.

Max Credits: 3
Min Credits: 3

91.212 Special Topics: Sound Thinking

Course ID: 35253

Course Details: Special Topics: Sound Thinking is an interdisciplinary elective for sophomore-level undergraduates that explores issues of sound production, musical form, or music in multimedia, depending on faculty and student interest. It is co-taught by Music and Computer Science Faculty.

Max Credits: 3
Min Credits: 3

91.301 Organization of Programming Languages

Course ID: 8076

Course Details: Analytical approach to the study of programming languages. Description of the salient features of the imperative, functional, logical, and object-oriented programming paradigms in a suitable metalanguage such as Scheme. Topics include iteration, recursion, higher-order functions, types, inheritance, unification, message passing, orders of evaluation, and scope rules. Elementary
syntactic and semantic descriptions. Implementation of simple interpreters.

Max Credits: 3
Min Credits: 3

91.304 Foundations of Computer Science

Course ID: 8077


Max Credits: 3
Min Credits: 3

91.305 Computer Architecture

Course ID: 8078

Course Details: Examines the basic functional components of a computer system including the CPU, memory systems, and I/O systems. Each of these three areas will be developed in detail with a focus on the system design and component integration. Topics will include CPU control and ALU operation, computer timing, data address and I/O bus activity, addressing model, programmed and DMA I/O, and instruction sets and micro code.

Max Credits: 3
Min Credits: 3

91.308 Operating Systems

Course ID: 1228

Course Details: Presents an introduction to major operating systems and their components. Topics include processes, concurrency and synchronization, deadlock, processor allocation, memory management, I/O devices and file management, and distributed processing. Techniques in operating system design, implementation, and evaluation will be examined.

Max Credits: 3
Min Credits: 3

91.309 Database I

Course ID: 8080

Course Details: This course surveys topics in database management systems. Topics include access methods, data models (relational, semantic, object-oriented and object-relational), query languages, database design, query optimization, concurrency control, recovery, security, integrity, client-server architecture, and distributed database systems. A database application project will be assigned.

Max Credits: 3
Min Credits: 3

91.310 Database II

Course ID: 8081

Course Details: Advanced topics in database systems, including distributed database systems, query optimization, concurrency control, knowledge bases, deductive databases, extendibility, and object-oriented database systems. Additional topics may include benchmarking, scientific databases, and parallelism. Software engineering principles will be applied to the development of components of a database management system.

Max Credits: 3
Min Credits: 3

91.350 Special Topics
Course ID: 8085
Course Details:
Max Credits: 3
Min Credits: 1

91.401 Software Project I

Course ID: 8093
Course Details: Specification, design, and implementation of a one- or two-semester software project proposed to a directing faculty member. Projects may be proposed as a one- or two-semester effort based on faculty approval. A two-semester effort requires subsequent registration for 91.402. Prerequisite: Students must submit a proposal to the directing faculty member, obtain his/her signed approval, and forward a copy of the signed proposal to department chairperson
Max Credits: 3
Min Credits: 3

91.404 Analysis of Algorithms

Course ID: 8095
Course Details: Development of more sophisticated ideas in data type and structure, with an introduction to the connection between data structures and the algorithms they support. Data abstraction. Controlled access structures. Trees, lists, graphs, arrays; algorithms design strategies; backtracking, greedy storage, divide and conquer, branch and bound. Elementary techniques for analysis: recursion equations, estimations methods, elementary combinatorial arguments. Examination of problem areas such as searching, sorting, shortest path, matrix and polynomial operations, and the indicated representations and algorithms. The student will use the techniques learned in this course and in previous courses to solve a number of logically complex programming problems.
Max Credits: 3
Min Credits: 3

91.405 Parallel Processing

Course ID: 8096
Course Details: A study of parallel architectures and parallel algorithms, including classification of architectures, characterization of performance, design of parallel algorithms, evaluation of parallel software, and languages for parallel processing. Students will write and execute programs for several different parallel machines.
Max Credits: 3
Min Credits: 3

91.406 Compiler Construction I

Course ID: 8097
Course Details: Includes both theory and practice. A study of grammars; specification and classes; the translation pipeline: lexical analysis, parsing, semantic analysis, code generation and optimization; and syntax-directed translation. Use of automatic generation tools in the actual production of a complete compiler for some language.
Max Credits: 3
Min Credits: 3

91.411 Software Engineering I

Course ID: 8099
Course Details: Software Engineering is an essential discipline for any computer science major. In this class you will learn skills that will help you design and build software projects for advanced computer science classes. This course provides an introduction to systematic techniques for development of software, i.e., "the Engineering of Software". Topics to be discussed include software life-cycle, group coordination, requirements specification, software design, software testing and software maintenance. Emphasis is given to the development of one complex software system and the system documentation necessary for such a complete software product. The students will mock the software cycle via a medium-to-large semester-long project.
91.412 Software Engineering II

Course ID: 8100

Course Details: Software development methodologies for large-scale systems. Project organization, life cycle concept, data modeling, structured analysis and design, information hiding, and the use of computer-aided software engineering (CASE) tools. Team projects are required; these emphasize the design, documentation, and maintenance of complex software systems. Not open to students who have taken 91.523 Software Engineering I.

Max Credits: 3
Min Credits: 3

91.413 Data Communications I

Course ID: 8101

Course Details: This course provides an introduction to fundamental concepts in the design and implementation of computer communication networks, their protocols, and applications. Topics include: TCP/IP and OSI layered network architectures and associated protocols, application layer, network programming API (sockets), transport, congestion, flow control, routing, addressing, autonomous systems, multicast and link layer. Examples will be drawn primarily from the Internet.

Max Credits: 3
Min Credits: 3

91.414 Data Communications II

Course ID: 8102

Course Details: A continuation of 91.413. Topics include Multimedia Networks, network Management, Network Security, Wireless and Mobile Networks. Students will track discussion in IETF committees and work in a dedicated network laboratory.

Max Credits: 3
Min Credits: 3

91.420 Artificial Intelligence

Course ID: 8104

Course Details: Discusses LISP, tree and graph searching algorithms: breadth first, depth first, and uniform cost. Also covers heuristic search methods, admissibility, and games: mini-max, alphaBeta. Students will learn theorem proving and question answering.

Max Credits: 3
Min Credits: 3

91.421 Data Mining

Course ID: 8105

Course Details: This introductory data mining course will give an overview of the models and algorithms used in data mining, including association rules, classification, clustering, etc. The course will teach the theory of these algorithms and students will learn how and why the algorithms work through computer labs.

Max Credits: 3
Min Credits: 3

91.427 Computer Graphics I

Course ID: 8107

Course Details: Introduction to graphics systems and concepts. History of graphics. Introduction to hardware, software, and mathematical tools. Graphics languages and APIs (GKS, PHIGS, Direct 3D, OpenGL). Graphics data structures and algorithms for 2D and 3D modeling and viewing. Input, archiving, and display architectures. Introduction to hidden line and hidden surface removal.
**91.428 Computer Graphics II**

Course ID: 8108

Course Details: An advanced course in computer graphics for students familiar with basic issues in computer graphics. Details on hidden line and surface removal, 2D and 3D curve and surface generation. Rendering, illumination, and color models. Realism through precision (ray tracing) and imprecision (fractals). Windowing and user interface management systems. Modern hardware architectures. Animation and simulation systems.

Max Credits: 3
Min Credits: 3

**91.450 Robotics I**

Course ID: 8111

Course Details: An introduction to robotics, including laboratory. In the lab, students build and program robots. Topics to be covered include sensors, locomotion, deliberative architectures, reactive architectures, and hybrid architectures.

Max Credits: 3
Min Credits: 3

**91.451 Robotics II**

Course ID: 8112

Course Details: Advanced topics in robotics, including laboratory. Topics to be covered include map making, path planning, computer vision and learning. Research-level robots are used in the laboratories.

Max Credits: 3
Min Credits: 3

**91.457 Computer Security**

Course ID: 8117

Course Details: Basic concepts of cryptography, data security, information theory, complexity, number theory, and finite field theory; encryption algorithms including the Data Encryption Standard (DES) and public key systems; incorporating cryptographic controls into computers; key management; access controls; information flow controls; and inference controls.

Max Credits: 3
Min Credits: 3

**91.460 Selected Topics**

Course ID: 8120

Course Details: Depends on faculty interest, student demand, and developments in the field.

Max Credits: 3
Min Credits: 3

**91.461 Graphical User Interface Programming I**

Course ID: 8121

Course Details: This is a first course in the design and implementation of graphical user interfaces (GUIs) for windowing environments. The course involves numerous programming projects that are evaluated on design and layout of the user interface, coding style, and comprehensiveness of documentation. The course may be taken on its own, but is intended to be followed by 91.462 to complete a two-course CS project sequence.
**91.462 Graphical User Interface Programming II**

Course ID: 8122

Course Details: A second course in the design and implementation of graphical user interfaces for windowing environments.

Max Credits: 3
Min Credits: 3

**91.490 Directed Studies in Computer Science**

Course ID: 8131

Course Details: Individual study for a student desiring more advanced or more specialized work. This course may not be taken more than twice and may not be substituted for scheduled offerings. Prerequisite: Students must submit a proposal to the directing faculty member, obtain his/her signed approval, and forward a copy of the signed proposal to the department chairperson.

Max Credits: 4
Min Credits: 1

**92.107 Elementary Math for Teaching: Numbers and Operations**

Course ID: 37557

Course Details: The Number and Operations course for elementary and middle school teachers examines the three main categories in the Number and Operations strand of Principles and Standards of School Mathematics (NCTM) -- Understanding numbers, representations, relationships, and number systems; the meanings of operations and relationships among those operations; and reasonable estimation and fluent computation. Not for Science / Engineering majors.

Max Credits: 3
Min Credits: 3

**92.111 Quantitative Reasoning**

Course ID: 8242

Course Details: An introduction to the mathematics concepts and skills important in modern society, even for non-technical pursuits. The course will emphasize conceptual understanding as well as a facility in performing elementary computations. Topics to be examined will include types of reasoning, problem-solving methods, techniques of estimation, algebraic essentials, and the nature of probability and statistics. No credit in Science or Engineering.

Max Credits: 3
Min Credits: 3

**92.111SI SI for Quantitative Reasoning & Introduction to Statistics**

Course ID: 8240

Course Details: This course provides supplemental instruction in mathematics to students whose Elementary Algebra Accuplacer exam scores indicate the need for such instruction. The credits in this course can not be used to satisfy the credits required for graduation, but may be used to satisfy the credits required for full time student status.

Max Credits: 2
Min Credits: 2

**92.121 Management Precalculus**

Course ID: 8245

Course Details: Review of algebra: operations on the real numbers, factoring, radical notation, and rational exponents. Linear and quadratic equations, rational expressions. Graphs of functions, straight lines, parabolas, exponential and log functions, systems of equations, and linear mathematical models. Prerequisites: No credit for math/science/engineering majors.
92.121SI Management Pre-Calculus Supplemental Instruction

Course ID: 36826

Course Details: Taken simultaneously with 92.121, this 1-credit course offers students retaking 92.121 supplemental instructions to foster a greater opportunity for successful completion of Management Precalculus. The course credit cannot be used to satisfy the credits required for graduation, but may be used to satisfy credits required for full time student status.

Max Credits: 1
Min Credits: 1

92.122 Management Calculus

Course ID: 8246

Course Details: Differential calculus: limits, continuity, derivatives, differentials, higher-order derivatives, implicit differentiation, maxima and minima of functions, and applications of derivatives to business and economics. Integrals and Applications to business. No credit in Science or Engineering.

Max Credits: 3
Min Credits: 3

92.123 Precalculus Mathematics II

Course ID: 8247

Course Details: Reviews angles and their measure, the trigonometric functions, solving triangles, law of sines, law of cosines, circular functions and their graphs, vectors and trigonometric identities. Not for Science / Engineering majors.

Max Credits: 3
Min Credits: 3

92.125 Calculus A

Course ID: 8249

Course Details: Serves as a first course in calculus and provides a brief review of analytic geometry and trigonometric functions. The course progresses to the study of inverse functions, limits, continuity, derivatives, rules for differentiation of algebraic and transcendental functions, chain rule, implicit differentiation, linear approximation, differentials, and maximum and minimum values.

Max Credits: 3
Min Credits: 3

92.126 Calculus B

Course ID: 8250

Course Details: Serves as a continuation of 92.125. The course covers L'Hopital's Rule, optimization problems, Newton's method, sigma notation, integration, area between curves, volume, arc length, surface area, integration by parts, trigonometric substitution, partial fraction decomposition, and improper integrals.

Max Credits: 3
Min Credits: 3

92.127 Preparation for Calculus

Course ID: 8251

Course Details: A review of precalculus (algebra and trigonometry) together with development of problem solving skills. No credit for math/Science/engineering majors.
Max Credits: 4
Min Credits: 4

92.128 Calculus IA

Course ID: 8252

Course Details: Provides a review of pre-calculus algebra and trigonometry integrated with the first half of Calculus I: limits, continuity, derivatives, basic derivative formulas, chain rule, implicit differentiation. For math/science/engineering majors, only two credits of this course may be applied toward a degree.

Max Credits: 4
Min Credits: 4

92.128SI Calculus IA Supplemental Instruction

Course ID: 38061

Course Details: Taken simultaneously with 92.128, this 1-credit course offers students retaking 92.128 supplemental instructions to foster a greater opportunity for successful completion of Calculus IA. The course credit cannot be used to satisfy the credits required for graduation, but may be used to satisfy credits required for full time student status.

Max Credits: 1
Min Credits: 1

92.129 Calculus IB

Course ID: 35267

Course Details: Provides a review of pre-calculus algebra and trigonometry integrated with the second half of Calculus I: L'Hospital's Rule, optimization problems, curve sketching, Newton's Method, antiderivatives. For math/science/engineering majors, only two credits of this course may be applied toward a degree. For pre-requisites, completion of this course is equivalent to 92.131 Calculus I.

Max Credits: 4
Min Credits: 4

92.131 Calculus I

Course ID: 8254

Course Details: Serves as a first course in calculus. Functions, limits, continuity, derivatives, rules for differentiation of algebraic and transcendental function; chain rule, implicit differentiation, related rate problems, max/min problems, and curve sketching. Integrals and areas.

Max Credits: 4
Min Credits: 4

92.132 Calculus II

Course ID: 8255

Course Details: Serves as a continuation of Calculus I. Volume, arc length, surface area, pressure and force. Differentiation and integration of trigonometric, inverse trigonometric, exponential, logarithmic, and hyperbolic functions. Improper integration, infinite series, Taylor and MacLauren series.

Max Credits: 4
Min Credits: 4

92.138 Calculus for the Life Sciences I

Course ID: 38099

Course Details: This is a single variable calculus course with applications to the life sciences. Review of basic algebra, functions and graphs. The Derivative: Basic definition, formulas and methods. Applications of differentiation, including curve sketching and maximum-minimum problems. Study of exponential and logarithmic functions motivated by growth, decay and logistic modes. Introduction to
integration, techniques, applications and the fundamental theorem. Approximation methods.

Max Credits: 4
Min Credits: 4

**92.141 Honors Calculus I**

Course ID: 8260  
Course Details: This course covers the same topics as 92.131 Calculus I, but in an enriched environment.
Max Credits: 4
Min Credits: 4

**92.142 Honors Calculus II**

Course ID: 8261  
Course Details: This course covers the same topics as 92.132 Calculus II, but in an enriched environment.
Max Credits: 4
Min Credits: 4

**92.151 Explorations in Mathematics**

Course ID: 8263  
Course Details: An introduction to the nature of mathematics, providing insights into what mathematics is, what it accomplishes, and how it is pursued as a human enterprise. The course will stress concepts and relevance to modern experience, with topics to be selected at the discretion of each instructor from a wide variety of interesting and illustrative fields of mathematics. No credit in Science or Engineering.
Max Credits: 3
Min Credits: 3

**92.210 Functions and Modeling**

Course ID: 37657  
Course Details: Engage in lab-based activities designed to strengthen their problem-solving skills and expand knowledge of the topics in secondary mathematics, focusing especially on topics from precalculus and the transition to calculus. Explore a variety of contexts that can be modeled using families of functions. Topics include conic sections, parametric equations and polar equations. Multiple representations, transformations, data analysis techniques and interconnections among geometry, probability and algebra. Quantitative approaches and building relationships between discrete and continuous reasoning will be recurrent themes.
Max Credits: 3
Min Credits: 3

**92.221 Linear Algebra I**

Course ID: 8281  
Course Details: Elementary set theory and solution sets of systems of linear equations. An introduction to proofs and the axiomatic methods through a study of the vector space axioms. Linear analytic geometry. Linear dependence and independence, subspaces, basis. Inner products. Matrix algebra. Applications of the above will also be discussed.
Max Credits: 3
Min Credits: 3

**92.222 Linear Algebra II**

Course ID: 8282  
Course Details: Linear transformations. Linear operators, change of basis, inner product and the diagonalization problem. Quadratic forms. Convex sets and geometric programming, input/output models for an economy, Markov chains, other applications of linear
algebra.
Max Credits: 3
Min Credits: 3

**92.225 Calculus C**

Course ID: 8285

Course Details: Serves as a continuation of 92.126. This course covers integration by parts, integration of trigonometric integrals, trigonometric substitution, partial fraction, numeric integration, improper integrals, L'Hopital's Rule, indeterminate forms, sequences, infinite series, integral tests, comparison tests, alternating series tests, power series, Taylor series, polar coordinates, graphs and areas in polar coordinates, and parametric equations.
Max Credits: 3
Min Credits: 3

**92.226 Calculus D**

Course ID: 8286

Course Details: Serves as a continuation of 92.225. This course covers curvature, cylindrical surfaces, dot and cross products, curves and planes in three space, cylindrical and spherical coordinates, functions of two variables, chain rule, directional derivatives and gradient, tangent planes, and double and triple integrals in rectangular, polar, cylindrical and spherical coordinate systems.
Max Credits: 3
Min Credits: 3

**92.227 Elementary Math for Teaching: Geometry and Measurement**

Course ID: 37459

Course Details: This is a mathematics content course which covers the geometry/measurement strands of the Massachusetts Curriculum Frameworks in Mathematics at a collegiate level. The goal is not only to prepare students for the elementary mathematics MTEL, but to lay the groundwork for graduate work in elementary mathematics education. The course centers around "Big Ideas" such as Equivalence, Proportionality, Transformations; and Shapes & Solids. Not for Science / Engineering majors.
Max Credits: 3
Min Credits: 3

**92.231 Calculus III**

Course ID: 8287

Course Details: Serves as a continuation of Calculus II Polar Coordinates, parametric equations, vectors and analytic geometry in space. Functions of several variables, partial derivatives, and chain rule. Tangent planes and normal lines. Maxima and minima, Lagrange multipliers, and multiple integrals.
Max Credits: 4
Min Credits: 4

**92.234 Differential Equations**

Course ID: 8289

Course Details: Classification and solution of ordinary differential equations of the first order and higher orders. The Laplace transform. Applications.
Max Credits: 3
Min Credits: 3

**92.236 Engineering Differential Equations**

Course ID: 8290
Course Details: Introduction to differential equations with an emphasis on engineering applications. Topics include first-order equations, higher-order linear equations with constant coefficients, and systems of first-order equations. Applications of each topic are introduced and qualitative, analytical, and numerical solution techniques are studied. Laplace transform methods are discussed. The software package MATLAB may be used throughout the course.

Max Credits: 3
Min Credits: 3

92.241 Honors Calculus III

Course ID: 8291
Course Details: Covers the same topics as 92.231 Calculus II, but in an enriched environment.
Max Credits: 4
Min Credits: 4

92.244 Honors Differential Equations

Course ID: 8293
Course Details: Introduction to differential equations. Topics include first-order equations, second-order and higher-order linear equations, systems of first-order linear equations with constant coefficients, and Laplace transforms.
Max Credits: 3
Min Credits: 3

92.283 Introduction to Statistics

Course ID: 8302
Course Details: An introduction to descriptive statistics, graphing and data analysis, probability laws, discrete and continuous probability distributions, correlation and regression, inferential statistics. No credit for Math, Science, or Engineering majors.
Max Credits: 3
Min Credits: 3

92.283SI SI for Quantitative Reasoning & Introduction to Statistics

Course ID: 8240
Course Details: This course provides supplemental instruction in mathematics to students whose Elementary Algebra Accuplacer exam scores indicate the need for such instruction. The credits in this course can not be used to satisfy the credits required for graduation, but may be used to satisfy the credits required for full time student status.
Max Credits: 2
Min Credits: 2

92.301 Introduction to Applied Mathematics I

Course ID: 8303
Course Details: Discusses vector analysis, Green's Theorem, Divergence Theorem, Stokes' Theorem, Fourier series, integrals, and partial differential equations of physics and engineering.
Max Credits: 3
Min Credits: 3

92.305 Introduction to Real Analysis I

Course ID: 8307
**92.321 Discrete Structures I**

Course ID: 8321

Course Details: Presents propositional logic, combinatorics, methods of proof, mathematical systems, algebra of sets, matrix algebra, relations and functions, recursion and generating functions, applications to computer science, and graph theory.

Max Credits: 3  
Min Credits: 3

**92.322 Discrete Structures II**

Course ID: 8322

Course Details: Examines graph theory, trees, algebraic systems, Boolean algebra, groups, monoids, automata, machines, rings and fields, applications to coding theory, logic design, and sorting.

Max Credits: 3  
Min Credits: 3

**92.330 Symbolic Logic**

Course ID: 8323

Course Details: This course is an introduction to symbolic logic. Symbolic logic provides a solid foundation in formal reasoning for students preparing for further study in mathematics, linguistics, cognitive science, computer science or philosophy. Topics include propositional logic, first-order logic and systems of deduction. Tarski's notion of model, and the completeness and incompleteness theorems of Gödel. Prerequisite: 92.321.

Max Credits: 3  
Min Credits: 3

**92.360 Mathematic Structure for Computer Engineers**

Course ID: 8327


Max Credits: 3  
Min Credits: 3

**92.362 Numerical Analysis I**

Course ID: 8328

Course Details: Focuses on the theory and application of numerical techniques including error analysis. Also discusses solution of linear, nonlinear and differential equations, interpolation, numerical integration, and curve fitting. Computer solutions are emphasized.

Max Credits: 3  
Min Credits: 3

**92.363 Intro to Data Analysis**

Course ID: 8329

Course Details: Computer analysis of data derived from research conducted in physical, social, and life sciences. Data preparation. Data modification, file manipulation, and descriptive statistics using SPSS. Programming ability is not required. No credit in Science or Engineering.

Max Credits: 3
Min Credits: 3

92.375 Senior Seminar I

Course ID: 30392

Course Details: Student works with an advisor to develop a proposal for a senior project that will be carried out as part of 92.475 Senior Seminar II. Generally taken during the spring of the junior year. Prerequisite: permission of instructor.

Max Credits: 1
Min Credits: 1

92.385 Applied Statistics

Course ID: 8340

Course Details: Introduction to experimental design, data analysis and formal statistical procedures from an applied point of view.

Max Credits: 3
Min Credits: 3

92.386 Probability and Statistics I

Course ID: 8341

Course Details: Provides a one-semester course in probability and statistics with applications in the engineering sciences. Probability of events, discrete and continuous random variables cumulative distribution, moment generatory functions, chi-square distribution, density functions, distributions. Introduction to estimation, hypothesis testing, regression and correlation.

Max Credits: 3
Min Credits: 3

92.403 Mathematical Analysis

Course ID: 8344

Course Details: The real numbers, completeness, sequences of real numbers, functions, continuity, uniform continuity, differentiability, the Riemann integral, series or real numbers, sequences and series of functions, uniform convergence, power series.

Max Credits: 3
Min Credits: 3

92.407 Probability and Mathematical Statistics I

Course ID: 8346

Course Details: Addresses the topics of probability, random variables, discrete and continuous densities, expectation and variance, special distributions (binomial, Poisson, normal, etc.), moment generating functions, joint and conditional distributions, transformations of variables, sampling, and the central limit theorem.

Max Credits: 3
Min Credits: 3

92.411 Complex Variables I

Course ID: 1227

Course Details: Discusses complex numbers, functions of a complex variable, mappings, derivatives, analytic functions, elementary functions. Laurent series, residues and poles, contour integration.

Max Credits: 3
Min Credits: 3

92.413 Number Theory
Course ID: 8351

Course Details: Studies congruencies and the Chinese Remainder Theorem, Primitive roots, quadratic reciprocity, approximation properties of continued fractions, Pell's equation. Recent application of number theory such as primality testing, cryptology, and random number generation will also be covered.

Max Credits: 3
Min Credits: 3

92.420 Mathematical Problem Solving

Course ID: 1226

Course Details: Focuses on: mathematical resources, ability to use heuristics, the student's beliefs about the use of mathematics to solve problems, and the student's self-confidence as a problem solver. Effective strategies for incorporating problem solving in the curriculum will also be discussed.

Max Credits: 3
Min Credits: 3

92.421 Abstract Algebra I

Course ID: 1225

Course Details: Elementary group theory, groups, cosets, normal subgroups, quotient groups, isomorphisms, homomorphisms, applications.

Max Credits: 3
Min Credits: 3

92.426 Topology

Course ID: 33480

Course Details: Metric spaces, topological spaces, connectedness, compactness, the fundamental group, classifications of surfaces, Brouwer's fixed point theorem.

Max Credits: 3
Min Credits: 3

92.427 Geometry

Course ID: 1224

Course Details: This course is designed for current and prospective geometry teachers. In addition to the development of Euclidean geometry, students will become familiar with geometry applications in Geometer's Sketchpad software, and to a lesser degree with other geometry software applications including Geogebra, Cabri, Maple and/or Mathematica. There will be an introduction to spherical and hyperbolic geometry and triangle measurements will be computed for each. Calculus based derivations of area and volume for surfaces and solids will be generated and related to Euclidean geometry topics.

Max Credits: 3
Min Credits: 3

92.435 History of Mathematics

Course ID: 1223

Course Details: Examines ancient numeral systems, Babylonian and Egyptian mathematics, Pythagorean mathematics, duplication, trisection, and quadrature, Euclid's elements and Greek mathematics after Euclid, Hindu and Arabian mathematics, European mathematics from 500 to 1600, origins of modern mathematics, analytic geometry, the history of calculus. Also covers the transition to the twentieth century and contemporary perspectives.

Max Credits: 3
Min Credits: 3
92.445 Partial Differential Equations

Course Details:
Max Credits: 3
Min Credits: 3

92.448 Mathematics of Signal Processing

Max Credits: 3
Min Credits: 3

92.450 Mathematical Modeling

Course Details: Applications of mathematics to real life problems. Topics include dimensional analysis, population dynamics wave and heat propagation, traffic flow.
Max Credits: 3
Min Credits: 3

92.466 Stat Program Using SAS

Course Details:
Max Credits: 3
Min Credits: 3

92.475 Senior Seminar II

Course Details: Undergraduate seminar on advanced mathematical topics. Students are required to develop an understanding of an advanced subject beyond the scope of an existing course or synthesize two or more different areas form their curriculum. Students are required to participate in the seminar, present their results to the Department and write a substantial thesis in their topic area. Essential course elements include library research, original research, and both verbal and written exposition. The first semester is a graduation requirement for majors in mathematics.
Max Credits: 3
Min Credits: 3

92.476 Senior Seminar III

Course Details: An optional second semester seminar to allow for continuation of study initiated in Senior Seminar I.
Max Credits: 3
Min Credits: 3

92.486 Probability and Math Statistics II

Course Details:
Max Credits: 3
Min Credits: 3

Max Credits: 3
Min Credits: 3

92.490 Selected Topics

Course ID: 8396

Course Details: Individual study for the student desiring more advanced or more specialized work. Course may not be substituted for scheduled offerings. Prerequisite: Permission of Department Chair.

Max Credits: 3
Min Credits: 1

92.491 Directed Study in Algebra

Course ID: 8397

Course Details: Individual study for the student desiring more advanced or more specialized work in algebra. May be repeated for a total of six semester credits. Course may not be substituted for scheduled offerings.

Max Credits: 3
Min Credits: 3

92.494 Directed Study in Statistics

Course ID: 8400

Course Details: Individual study for the student desiring more advanced or more specialized work in Statistics. May be repeated for a total of six semester credits. Course may not be substituted for scheduled offerings. Prerequisite: Permission of Department Chair.

Max Credits: 3
Min Credits: 3

94.301 Organization of Programming Languages

Course ID: 30805

Course Details: Analytical approach to the study of programming languages. Description of the salient features of the imperative, functional, logical, and object-oriented programming paradigms in a suitable metalanguage such as Scheme. Topics include iteration, recursion, higher-order functions, types, inheritance, unification, message passing, orders of evaluation, and scope rules. Elementary syntactic and semantic descriptions. Implementation of simple interpreters. Note: This course is for CS graduate students needing to fulfill prerequisite requirements. It is not available to CS undergraduates without specific permission from the Undergraduate Coordinator.

Max Credits: 3
Min Credits: 3

94.304 Foundations of Computer Science

Course ID: 34537

Course Details: A survey of the mathematical foundations of Computer Science. Finite automata and regular languages. Stack Acceptors and Context-Free Languages. Turing Machines, recursive and recursively enumerable sets. Decidability. Complexity. This course involves no computer programming. This course is for CS graduate students needing it to fulfill prerequisite requirements. It is not available to CS undergraduates without specific permission from the Undergraduate Coordinator.

Max Credits: 3
Min Credits: 3

94.305 Computer Architecture
Course ID: 30806

Course Details: Examines the basic functional components of a computer system including the CPU, memory systems, and I/O systems. Each of these three areas will be developed in detail with a focus on the system design and component integration. Topics will include CPU control and ALU operation, computer timing, data address and I/O bus activity, addressing model, programmed and DMA I/O, and instruction sets and micro code. This course is for CS graduate students needing it to fulfill prerequisite requirements. It is not available to CS undergraduates without specific permission from the Undergraduate Coordinator.

Max Credits: 3
Min Credits: 3

94.308 Introduction to Operating Systems

Course ID: 30807

Course Details: Presents an introduction to major operating systems and their components. Topics include processes, concurrency and synchronization, deadlock, processor allocation, memory management, I/O devices and file management, and distributed processing. Techniques in operating system design, implementation, and evaluation will be examined. This course is for CS graduate students needing it to fulfill prerequisite requirements. It is not available to CS undergraduates without specific permission from the Undergraduate Coordinator.

Max Credits: 3
Min Credits: 3

94.404 Analysis of Algorithms

Course ID: 30808

Course Details: Development of more sophisticated ideas in data type and structure, with an introduction to the connection between data structures and the algorithms they support. Data abstraction. Controlled access structures. Trees, lists, graphs, arrays; algorithms design strategies; backtracking, greedy storage, divide and conquer, branch and bound. Elementary techniques for analysis; recursion equations, estimations methods, elementary combinatorial arguments. Examination of problem areas such as searching, sorting, shortest path, matrix and polynomial operations, and the indicated representations and algorithms. The student will use the techniques learned in this course and in previous courses to solve a number of logically complex programming problems. This course is for CS graduate students needing it to fulfill prerequisite requirements. It is not available to CS undergraduates without specific permission from the Undergraduate Coordinator.

Max Credits: 3
Min Credits: 3

95.101 Introductory Physics

Course ID: 8523

Course Details: A survey course for students majoring in sound recording technology. Topics covered include: one and two dimensional motion, Newton's Laws of dynamics, statics, circular motion, work and energy, linear and angular momentum, electrostatics, electric and potential fields, magnetic fields, vibrations, waves, sound, Faraday's Law and AC circuits.

Max Credits: 3
Min Credits: 3

95.103 General Physics I

Course ID: 8524

Course Details: Serves as the first semester of a one-year course which surveys the field of physics at a non-calculus level. Topics include force and motion, vectors, gravity, energy and momentum, heat and thermodynamics, and oscillations, waves and sound. Although the course emphasizes conceptual understanding, a functional knowledge of algebra and geometry is essential.

Max Credits: 3
Min Credits: 3

95.104 General Physics II

Course ID: 8525
Course Details: Provides a continuation of 95.103. Topics include electricity and magnetism, geometrical and physical optics, atoms, and nuclei.

Max Credits: 3
Min Credits: 3

95.111 Undeclared Science Seminar

Course ID: 8526

Course Details: Discussions will be conducted on a wide range of topics in the sciences to familiarize the student with the programs, procedures, research and educational opportunities at the University.

Max Credits: 1
Min Credits: 1

95.112 Freshman Physics Seminar

Course ID: 8527

Course Details: An introduction to the scientific methods of physics and the exploration of research opportunities for undergraduates.

Max Credits: 1
Min Credits: 1

95.121 Exploring the Universe

Course ID: 8528

Course Details: Addresses topics that include: Planet Earth, its structure, plate tectonics, greenhouse effect, ozone layer, craters and dinosaurs; our satellite Moon; other planets; our star Sun and its energy source; other stars, the HR diagram and stellar evolution, white dwarfs, neutron stars, supernovae, black holes; our galaxy, the Milky Way; its structure; other galaxies; the universe, its structures and expansion; evolution of galaxies, quasars, cosmology, the Big Bang and Unification of the forces of nature. Satisfies Gen Ed science requirements for non-science majors. Does not satisfy science requirements for Science majors but may be used as a free elective by Science majors.

Max Credits: 3
Min Credits: 3

95.141 Physics I

Course ID: 8529

Course Details: First semester of a two-semester sequence for science and engineering majors. Mechanics including vectors, kinematics in one and two dimensions, Newton's laws of dynamics, work and energy, energy conservation, linear momentum conservation, rotational kinematics and dynamics, Newton's Universal Law of Gravitation, oscillatory motion and mechanical waves.

Max Credits: 3
Min Credits: 3

95.144 Physics II

Course ID: 8531

Course Details: Continuation of 95.141. Optics including interference, and diffraction. Electricity and magnetism including Coulomb's Law, electric field, Gauss' Law, electric potential, Ohm's Law, DC circuits with resistors, magnetic field, Ampere's Law, Faraday's Law, inductance, Maxwell's equations, and electromagnetic waves. Modern physics including deBroglie waves, uncertainty principle, photoelectric effect, hydrogen atom and the stability of the Bohr orbits, and atomic spectrum of hydrogen.

Max Credits: 3
Min Credits: 3

95.161 Honors Physics I
Course Details: Introductory mechanics at a more challenging level and the first semester of a sequence for physics majors. Mechanics of particles in one dimension, kinematics, forces, dynamics; particles in two and three dimensions, vectors, curvilinear and oscillatory motion; conservation principles, work, energy, linear momentum, collisions; rotational mechanics, angular momentum, torque and static equilibrium; gravitation and planetary orbits; wave motion, transverse and longitudinal, standing waves.

Max Credits: 4
Min Credits: 4

95.164 Honors Physics II

Course Details: Geometrical optics, reflection, refraction, flat and curved mirrors, thin lenses; physical optics, interference and diffraction; electrostatics, charge, electric forces, fields and flux, electric potential, capacitance and field energy; electric charge in motion, currents, DC and RC circuits; magnetic fields, forces on moving charges, magnetic field of an electric current, electromagnetic induction, inductance, changing currents, AC circuits; electromagnetic radiation; the limits of classical electromagnetic theory.

Max Credits: 4
Min Credits: 4

95.204 Introduction to Radiological Sciences

Course Details: This course is designed to introduce students to the working practices encountered in health physics. This is accomplished through field trips to local facilities that use radioactive materials, laboratory exercises, and class discussions. This class exposes the student to basic health physics procedures, vocabulary, and equipment.

Max Credits: 3
Min Credits: 3

95.210 Introductory Modern Physics

Course Details: Special theory of relativity, experimental basis of quantum theory, structure of the atom, wave properties of matter, quantum theory, hydrogen atom, atomic nucleus, nuclear interactions and applications, and semiconductors.

Max Credits: 3
Min Credits: 3

95.245 Physical Properties of Matter

Course Details: Fluid statics, dynamics of fluids, properties of solids, advanced topics in waves and vibrations, temperature and heat flow, kinetic theory of gases, thermodynamics, and the limits of classical physics.

Max Credits: 3
Min Credits: 3

95.269 Honors Physics III

Course Details: Statics and dynamics of fluids, pressure, viscosity, Archimedes and Bernoulli principles, mechanical properties of solids, stress and strain, shear, electric and magnetic properties of materials, para- dia- and ferromagnetism, electro-mechanical and magneto-mechanical effects, hysteresis, advanced topics in waves and vibrations, damping, resonance in mechanical and AC oscillators, thermodynamics, Maxwell's velocity distribution, blackbody radiation, and the limits of classical physics, introduction to special relativity.

Max Credits: 4
Min Credits: 4
95.300 Introduction to Radiological Sciences

Course ID: 36770

Course Details: This course is designed to introduce students to the working practices encountered in the health physics and medical physics profession. This is accomplished through field trips to local facilities that use radioactive materials, use and calibrations of radiological instrumentation, laboratory exercises, and class discussions. This class exposes the student to basic health and medical physics procedures, vocabulary, and equipment.

Max Credits: 3
Min Credits: 3

95.304 Vibration and Sound

Course ID: 37507

Course Details: The course serves to integrate the various sub-topics of physics that undergraduate majors have experienced by exploring the physical processes of vibrations of lumped and continuous electrical mechanical and acoustic systems: the damped harmonic oscillator in electrical and mechanical form, the flexible string in tension and the coaxial cable with differing end conditions, vibrations of bars, membranes and plates, plane waves of sound, standing waves, radiation and scattering. Throughout reference is made to analogous process in the quantum mechanical domain. Closely coordinated with the recitations is the co-requisite laboratory course, which provides concrete experience with the phenomena discussed in the recitations.

Max Credits: 3
Min Credits: 3

95.308 Physics with Computers I

Course ID: 8549

Course Details: Max Credits: 3
Min Credits: 3

95.316 Science and Technology in an Impoverished World

Course ID: 37509

Course Details: Intended for junior-level science and engineering majors, this is a one-semester 3-credit course focused of the impact of science and technology in poverty stricken regions of the world. Students will be challenged to consider the implementation of past and present technologies for solving resource shortages, evaluate and strengths and limitations of these solutions while developing alternatives to address future barriers to positive change. Encouraged to work toward these issues, students will: 1) Pursue and evaluate topics in science and technology through the skills of inquiry, research, critical thinking and problem solving. 2) Demonstrate the knowledge for quantitative and qualitative analysis of problems in science and technology. #0 Analyze and interpret issues in interdisciplinary areas of science and engineering developing a level of comfort with solving unfamiliar problems using acquired knowledge and skills.

Max Credits: 3
Min Credits: 3

95.338 Optics and Waves

Course ID: 8557

Course Details: Wave nature of light, mathematics of wave motion, electromagnetic theory of light propagation, reflection and refraction, Fresnel coefficients, polarization, interference, Young’s experiment, fringe visibility and coherence, various interferometers, Newton’s ring and applications, Fraunhofer diffraction by single and multiple apertures and diffraction gratings.

Max Credits: 3
Min Credits: 3

95.353 Electromagnetism I

Course ID: 1216
Course Details: The theory of electromagnetic fields using vector analysis: electrostatic fields and potentials in vacuum, conductors, and dielectric media, magnetic effects of steady currents in nonmagnetic media, magnetic induction and time varying currents and fields. (offered as 95.553 for graduate credit)

Max Credits: 3
Min Credits: 3

95.354 Electromagnetism II

Course ID: 1215

Course Details: Magnetic materials, electric multipoles, solutions to Laplace’s equation, boundary conditions, image charge problems, Maxwell's equations; propagation of electromagnetic waves in vacuum, conductors and dielectrics; reflection and refraction of electromagnetic waves; radiation from dipoles and antennas. (offered as 95.554 for graduate credit).

Max Credits: 3
Min Credits: 3

95.381 Mathematical Physics I

Course ID: 36219

Course Details: Intended for students having completed 2 full years of physics and math, this course is designed to develop competency in the applied mathematical skills required of junior and senior level physics majors. Covering topics involving infinite series, power series, complex numbers, and linear algebra along with vector and Fourier analysis, students will be trained with the rigor required to solve a wide range of applications in the physical sciences.

Max Credits: 3
Min Credits: 3

95.382 Mathematical Physics II

Course ID: 36220

Course Details: Expanding on the skills mastered in 95.381 Mathematical Physics I, this course is designed to continue developing competency in the applied mathematics required of junior and senior level physics majors. Intended for students having completed at least 2 years of physics and math, topics covered will involve ordinary, differential equations, calculus of variations, tensor analysis, special functions, series solutions of differential equations, partial differential equations, and complex variables as well as probability and statistics. Students will be trained with the rigor required to solve a wide range of applications in the physical sciences.

Max Credits: 3
Min Credits: 3

95.383 Astronomy and Astrophysics I

Course ID: 8560

Course Details: This course is designed for an interdisciplinary general undergraduate (upperclassmen) audience. Fundamentals of astronomy and astromechanics, introductory survey of astrophysics and the solar system (i.e. planetary astronomy).

Max Credits: 3
Min Credits: 3

95.401 Radiation Safety and Control I

Course ID: 8562

Course Details: Introduction to radiation protection, including radiation sources, radiation dose and dose measurement, radiation exposure, radiation protection techniques, monitoring methods and instruments, contamination control and waste storage, facility design, hazards analysis, and applied health physics techniques for the safe handling and control of radioactive material including laboratory. (offered as 98.501 for graduate credit)

Max Credits: 4
Min Credits: 4
95.402 Radiation Safety and Control II

Course ID: 8563

Course Details: A laboratory course giving students experience with equipment and practices of current use in the radiation protection field, and extension of 98.401 giving some of the practical aspects of radiation safety and control. (offered as 98.502 for graduate credit)

Max Credits: 4
Min Credits: 4

95.411 Physics Perspectives

Course ID: 8565

Course Details: Discussions on the role of the professional physicist in society.

Max Credits: 1
Min Credits: 1

95.413 Mechanics

Course ID: 1221


Max Credits: 3
Min Credits: 3

95.421 Statistical Thermodynamics

Course ID: 1220

Course Details: An integrated study of the thermodynamics and statistical mechanics, review of the experimental foundations and historical development of classical thermodynamics; probability and statistical methods of studying macroscopic systems; atomic basis of the laws of thermodynamics and microscopic definitions of thermodynamics quantities using the method of ensembles; entropy and related quantities; TdS equations, Maxwell relations, equation of state, and applications: canonical and grand canonical ensembles; phase transitions; quantum statistics; application to radiation, magnetism, specific heats. (offered as 95.521 for graduate credit)

Max Credits: 3
Min Credits: 3

95.424 Environmental Health Physics

Course ID: 37592

Course Details: Natural and man-made sources of environmental radioactivity and radiation; environmental transport in air, water, and soil; exposure pathways; environmental standards and regulations; environmental monitoring and surveys (MARSSIM); contaminated site characterization, and site remediation; environmental radiological impact of industry, accidents, and natural and man-made disasters.

Max Credits: 3
Min Credits: 3

95.435 Introductory Quantum Mechanics I

Course ID: 1219

Course Details: De Broglie waves, the Schroedinger equation, wave functions, wave packets, Heisenberguncertainty principle, expectation values, particle in a box, the simple harmonic oscillator, free particles, step barrier, barrier penetration, square well potential, time independent perturbation theory. (offered as 95.535 for graduate credit)

Max Credits: 3
Min Credits: 3
95.436 Introductory Quantum Mechanics II

Course ID: 8567

Course Details: The three dimensional Schroedinger equation, the deuteron nucleus, angular momentum, spin, the hydrogen atom, spin-orbit interaction, Zeeman effect, Pauli exclusion principle, atomic structure, multi-electron atoms, the Fermi gas, X-rays. (offered as 95.536 for graduate credit)

Max Credits: 3
Min Credits: 3

95.439 Electro-Optics

Course ID: 1218

Course Details: Optical properties of materials, including dispersion, absorption, reflection and refraction at the boundary of two media. Crystal optics and induced birefringence and optical activity. Polarization states and Jones matrices. Applications to electro-optic devices. Experiments and projects involving the study of optical sources and detectors, spectroscopy, polarization, birefringence, pockels’ effect, optical fibers, and optical communication. (offered as 95.539 for graduate credit)

Max Credits: 3
Min Credits: 3

95.440 Image Processing

Course ID: 8568

Course Details: Basic physics of television and other imaging systems: representation and manipulation of images in digital form; Fourier analysis and filtering of images: detection of image features such as edges and regions; pattern recognition; three-dimensional visual perception in man and machine; examples of image processing tasks from such areas as medicine, industrial inspection and robotics; laboratory exercises with an image processing system utilizing an Octec 2000 image analyzer and a Data General Nova 4/C Computer. Ability to program a computer is required. (offered as 95.540 for graduate credit)

Max Credits: 4
Min Credits: 4

95.441 Radiochemistry

Course ID: 8569

Course Details: This course stresses analytical techniques applicable to identification and quantification of radionuclides in various sample types. Considerable time will be spent on review of general chemistry and inorganic analytical chemistry. The theories and applications of various separation techniques including precipitation, solvent extraction, ion exchange chromatography, and electrodeposition will be discussed with emphasis on separation of radioactive species. Additional material to be covered includes instrumental techniques for analysis of radioactive species, radiotracer and isotope dilution techniques, neutron activation analysis, and sample preparation.

Max Credits: 3
Min Credits: 3

95.447 Laser Physics and Applications

Course ID: 1217

Course Details: Spontaneous and stimulated emission line broadening processing, rate equations, laser oscillation condition, spectral output of lasers. Gaussian beam propagation and resonator design parameters. Key features of ultraviolet through far infrared laser systems. Application to spectroscopy, radar, welding. (offered as 95.547 for graduate credit)

Max Credits: 3
Min Credits: 3

95.453 Health Physics Capstone

Course ID: 35837
Course Details: This course will provide the B.S. candidate in Physics (Radiological Health Physics option) with an undergraduate capstone experience through basic independent research, including critical thinking, problem solving, report writing, and presentation skills.

Max Credits: 3
Min Credits: 3

**95.454 Physics Capstone**

Course ID: 30755

Course Details: This course will provide the graduating physics major with a capstone experience through an exposure to the rudiments of independent research; incorporating critical thinking, problem-solving, report-writing, and presentation skills learnt in the course of the undergraduate curriculum. Prerequisite: Senior Status.

Max Credits: 3
Min Credits: 3

**95.461 Nuclear Physics I**

Course ID: 1214

Course Details: Nuclear properties including size, mass, binding energy, electromagnetic moments, parity and statistics; nuclear shell model, collective structure, deformed shell model, radioactive decay law and the Bateman equations, radioactive dating, counting statistics, energy resolution, coincidence measurements and time resolution, lifetime measurements; nuclear barrier penetration; angular momentum, Coulomb barrier, alpha decay and systematics, fission. (offered as 95.561 for graduate credit).

Max Credits: 3
Min Credits: 3

**95.462 Radiation Biology**

Course ID: 8573

Course Details: Effects of ionizing radiation on cellular, molecular and organ systems levels of biological organization; Study of x-rays, gamma rays, accelerator beams, and neutrons in interaction with living systems; Cohesive treatment of radiation biophysics with applications in health physics and radiation oncology. (offered as 98.562 for graduate credit)

Max Credits: 3
Min Credits: 3

**95.472 Solid State Physics**

Course ID: 1213

Course Details: Crystal structures, x-ray diffraction, crystal binding, lattice vibrations, free electron and band models of metals. (offered as 95.572 for graduate credit).

Max Credits: 3
Min Credits: 3

**95.477 Solid State Electronic and Optoelectronic Devices**

Course ID: 1212

Course Details: This course is an introduction to solid state electronic and optoelectronic devices for undergraduate science students (i.e. biology, chemistry, mechanical engineering, electrical engineering, physics, etc.) graduate students just entering a scientific endeavor which utilizes solid state devices, and practical engineers and scientists whose understanding of modern electronics and optoelectronics needs updating. The course is organized to bring students with a background in sophomore physics to a level of understanding which will allow them to read much of the current literature on new devices and applications. The course will cover fundamental crystal properties, atoms and electrons, energy bands and charge carriers, excess carriers, junctions and p-n junction diodes (includes photodiodes and light-emitting diodes). Three or four practical demonstrations will also be performed with the analysis of the generated data assigned as homework. (offered as 95.577 for graduate credit)

Max Credits: 3
**95.478 Integrated Optics: Wave Guides and Lasers**

Course ID: 1211

Course Details: This course is a continuation of 95.477 and serves as an introduction to solid state electronic and optoelectronic devices. The course will cover bipolar junction transistors, field effect transistors, integrated circuits, lasers, switching devices, and negative conductance microwave devices. Three or four practical demonstrations will also be performed with the analysis of the generated data assigned as homework. (offered as 95.548 for graduate credit)

Max Credits: 3

Min Credits: 3

**95.481 Mathematical Methods of Radiological Sciences**

Course ID: 8574

Course Details: An applied course emphasizing the mathematical skills used in radiological sciences/health physics fields, including special techniques used in radiation physics, radiation dosimetry, and radiation shielding. Computer applications will be emphasized. (offered as 98.581 for graduate credit)

Max Credits: 3

Min Credits: 3

**95.482 Numerical Methods of Radiological Sciences**

Course ID: 8575

Course Details: Advanced mathematical treatment of topics covered in 98.481 with extensive application of computer techniques to problem solutions applicable to Radiological Sciences and Protection. (offered as 98.582 for graduate credit)

Max Credits: 3

Min Credits: 3

**96.101 Introductory Experimental Physics**

Course ID: 8666

Course Details: Experimental physics with topics correlated with the corequisite lecture course.

Max Credits: 1

Min Credits: 1

**96.103 General Physics I Lab**

Course ID: 8667

Course Details: Presents the first semester of a one-year course which surveys the field of experimental physics with topics correlated to the corequisite lecture course.

Max Credits: 1

Min Credits: 1

**96.104 General Physics II Lab**

Course ID: 8668

Course Details: Serves as a continuation of 96.103 with topics correlated with the corequisite lecture course.

Max Credits: 1

Min Credits: 1

**96.105 Sounds of Music**
Course Details: Examines the physical process that makes musical sounds from acoustic instruments. Hands-on laboratory experiences explore how the vibrations of strings, air columns, membranes, plate and bars are transformed into musical sounds, how these propagate and are transformed by the listening space, and how these are received by ears and perceived by the brain. In addition, harmonic series, the mean-tempered scale, the use of decibels, sonic interference and diffraction are explained.

Max Credits: 3
Min Credits: 3

96.141 Physics I Lab

Course Details: Serves as an introductory course on methods and techniques of experimentation in physics with experiments in mechanics selected to support the concepts of the corequisite lecture course.

Max Credits: 1
Min Credits: 1

96.144 Physics II Lab

Course Details: Serves as a continuation of 96.141 with experiments in optics, electricity and magnetism, and modern physics to support the concepts of the corequisite lecture course.

Max Credits: 1
Min Credits: 1

96.161 Honors Physics I Laboratory

Course Details: An introductory laboratory course at the honors level on the methods and techniques of experimental physics. Lectures on measurement uncertainties and error analysis are included and experiments are selected principally in mechanics.

Max Credits: 2
Min Credits: 2

96.164 Honors Physics Lab II

Course Details: A continuation of 96.161 with experiments selected principally in optics, electricity and magnetism.

Max Credits: 2
Min Credits: 2

96.201 Health Physics Internship I

Course Details: Applied work experience as a health physics technician at a government laboratory or a radiation facility of some industry, hospital, or education and research institution.

Max Credits: 3
Min Credits: 3

96.245 Physics III Lab

Course Details: Experiments are selected principally in properties of solids, vibrations, waves, heat, and thermodynamics.
96.261 The Physics of Materials and Devices

Course ID: 32070

Course Details: Investigating the phenomenology of materials involve sensing devices in which electrical signals must be evaluated. Observing physical phenomena with an electrical sensing device enables one to calibrate the dynamics of the electrical signal associated with the changes in the physical phenomenology observed with that device. Applications in these laboratory-based measurement techniques include the Wheatstone bridge, current/voltage device characterization, the operational amplifier as an active filter, stress & strain, Newton's law of cooling, Stefan/Boltzmann's law and the ideal gas law.

Max Credits: 1
Min Credits: 1

96.262 Principles in Laboratory Automation

Course ID: 8687

Course Details: This is an introduction to the principles of automating today's research laboratory. A foundation of the Labview-based software and hardware tools required to conduct computer-controlled experiments will be presented, demonstrated and then used to acquire, display and analyze data on some typical physical phenomena. Students will be fully involved in designing the control and acquisition software as well as setting up the experimental hardware. Applications of the automated acquisition environment include AC characterization of RC and LRC circuits, the use of thermistors and thermocouples along with acquiring the temperature dependent resistivity of high Tc super conductors.

Max Credits: 3
Min Credits: 3

96.301 Health Physics Internship II

Course ID: 8691

Course Details:

Max Credits: 3
Min Credits: 1

96.302 Health Physics Internship II

Course ID: 8692

Course Details:

Max Credits: 3
Min Credits: 3

96.304 Vibration and Sound Lab

Course ID: 37506

Course Details: A series of four directed four-hour experiments and one student directed experiment all of which are coordinated with Vibration and Sound 95.304. Emphasis is on non-intrusive measurement techniques; choosing, evaluating and applying appropriate transducers and structuring data processing and display in measurements of transfer functions. Impedances and modal structures for the system studied analytically in the companion course.

Max Credits: 1
Min Credits: 1

96.393 Advanced Experimental Physics Laboratory I

Course ID: 8699
96.394 Advanced Physics Lab II
Course ID: 8700
Course Details: A continuation of 96.393 with experiments selected mainly from condensed matter and nuclear physics. Opportunities for independent work by permission of the instructor.
Max Credits: 2
Min Credits: 2

96.401 Radiation Safety And Control I
Course ID: 8701
Course Details:
Max Credits: 0
Min Credits: 0

96.406 Nuclear Instrumentation
Course ID: 36046
Course Details: This course provides the operating principles and applications of nuclear radiation detection systems, including detector theory, electronic signal processing, and measurement and data reduction techniques. The systems covered include gas-filled detectors (ion chambers, proportional counters, and Geiger-Mueller counters), inorganic and organic scintillators, and high-purity germanium detectors, for the detection of alpha, beta, gamma, and neutron radiation. This course also covers hypothesis testing, detection limits, and detector dead time (offered as 98.506 for graduate credit).
Max Credits: 4
Min Credits: 4

96.409 Nuclear Instrumentation
Course ID: 37351
Course Details: This course provides the operating principles and applications of nuclear radiation detection systems, including detector theory, electronic signal processing, and measurement and data reduction techniques. The systems covered include gas-filled detectors (ion chambers, proportional counters, and Geiger-Mueller counters), inorganic and organic scintillators, and high-purity germanium detectors, for the detection of alpha, beta, gamma, and neutron radiation. This course also covers hypothesis testing, detection limits, and detector dead time. This course is adapted for Nuclear Engineering and Medical Physics majors. (offered as 98.509 for graduate credit).
Max Credits: 3
Min Credits: 3

96.411 Senior Research In Radiological Sciences
Course ID: 8703
Course Details: A research problem related to the field of radiation protection is investigated by the student under the direction of faculty and staff of the Nuclear Center. The student will present a seminar on this research project. Areas of research may include radiation shielding, radiation detection and measurement, radiation survey and monitoring, radiation biology, radiation chemistry, radiobiology, radiochemistry, radioecology, natural radioactivity, fallout, analyses and measurement of radioactivity and radiation levels associated with the operation of reactors and accelerators, and radioactive aerosols.
Max Credits: 3
Min Credits: 3

96.445 Characterization of Materials
Course ID: 35486

Course Details: A one-semester course designed to teach the student several of the important techniques for characterizing the structural, optical, and electronic properties of materials. Experiments will include x-ray diffractometry, hardness measurements, ellipsometry, visible and near infrared spectroscopy, far infrared spectroscopy, and raman spectroscopy.

Max Credits: 2
Min Credits: 2

96.453 Optics Project

Course ID: 8710
Course Details:
Max Credits: 3
Min Credits: 3

96.467 Automation Techniques

Course ID: 30830
Course Details: Students explore the techniques and sensor technologies of automating measurement acquisition and analysis in a research laboratory. The Labview-based software and hardware tools required to conduct computer-controlled experiments will be presented, demonstrated and then used to acquire, display and analyze data for a number sensors. Students will be expected to master the design of control and acquisition software as well as setting up the experimental hardware. Applications of the automated acquisition environment include AC characterization of operational amplifiers and active filters as well as the RC time characteristics of photoconductors and thermocouples. Advanced projects individualized to the student's field of interest are required.

Max Credits: 3
Min Credits: 3

96.495 Special Research Problems I

Course ID: 8713
Course Details: Special problems in physics assigned to the individual student with emphasis on modern research methods and preparation of results for publication.

Max Credits: 3
Min Credits: 3

96.496 Special Research Problems II

Course ID: 8714
Course Details: A continuation of 96.495 for a second semester.

Max Credits: 3
Min Credits: 3

96.497 Senior Thesis in Physics

Course ID: 8715
Course Details:
Max Credits: 3
Min Credits: 3

99.101 Radiation and Life

Course ID: 8906
Course Details: This course will provide students with an understanding of the nature, sources, uses, and biological effects of natural and man-made radiations. Radiations discussed include non-ionizing radiations such as ultraviolet and microwave as well as the ionizing radiations produced by radon in homes and radio nuclides released from nuclear power plants. Students will have a better understanding of the risks and benefits of radiation in the modern world. Satisfies Gen Ed science requirements for non-science majors. Does not satisfy science requirements for Science majors but may be used as a free elective by Science majors.

Max Credits: 3
Min Credits: 3

99.102 Radiation and Life Laboratory

Course ID: 8907

Course Details: This laboratory course which is suitable for non-science majors will provide the student with an opportunity for some hands-on experience with modern equipment used to identify and quantify levels of radioactivity in the environment. Students will measure radiation from a variety of sources and will determine concentrations of radionuclides in several environmental samples including making measurements of the radon levels in the air of their own homes. Students will also study the effects of ionizing radiation on the germination and growth rate of exposed seeds. Satisfies Gen Ed science requirements for non-science majors. Does not satisfy science requirements for Science majors but may be used as a free elective by Science majors.

Max Credits: 1
Min Credits: 1

99.131 Technical Physics I

Course ID: 8909

Course Details: Presents material in both the class and laboratory format. Topics include: vectors; one- and two- dimensional motion; Newton's laws of motion; translational and rotational equilibrium; work and energy; linear momentum; and circular motion and gravitation. Two additional Friday night classes are required.

Max Credits: 3
Min Credits: 3

99.132 Technical Physics II

Course ID: 8910

Course Details: Covers material in both the class and laboratory format. Rotational dynamics; mechanical vibrations and waves; sound; solids and fluids; thermal physics; heat and law of thermodynamics will be discussed. One session per week. Two additional Friday night classes are required.

Max Credits: 3
Min Credits: 3

99.133 Technical Physics III

Course ID: 8911

Course Details: Presents material in both the class and laboratory format. Reflection, refraction, mirrors, lenses, wave optics, optical instruments, Coulomb's law, magnetic force, quantum physics, atomic physics and nuclear physics will each be addressed. One session per week. Two additional Friday night classes are required.

Max Credits: 3
Min Credits: 3

81.205 Endocrinopathies

Course ID: 7476

Course Details:

Max Credits: 3
Min Credits: 3
81.244 Biodiversity & Conservation Australia's Tropics

Course ID: 38121

Course Details: The most diverse ecosystems in the world are Australia's Great Barrier Reef and Daintree Tropical rain forest. To explore the basic principles of biodiversity and conservation biology we will use the case studies of the coral reefs and tropical rainforest of Cairns, Australia. The course will start off at UML, studying three aspects of biodiversity: its origin, the threats, and its conservation. Next we will go to Australia where students will experience the wonders of these ecosystems, and learn first hand about the scientific research on the flora and fauna, and learn about the efforts to conserve these treasures. Students will participate in restoration projects of the tropical rainforest and coral reefs, and hear lectures on conservation from scientific researchers to the Aborigines.

Max Credits: 6
Min Credits: 6

81.406 Environment Microbiology Laboratory

Course ID: 7511

Course Details:
Max Credits: 1
Min Credits: 1

81.429 Recombinant Protein Production Techniques

Course ID: 38228

Course Details: This course introduces students to the principles and practice of recombinant protein expression and purification's. Proteins are major targets of pharmaceuticals, and are themselves increasingly used as therapeuticals. However both basic research and pharmaceutical industry depends on availability of purified proteins that are often difficult to isolate from native sources. This course will provide both didactic and laboratory instruction. It is comprised of a series of lecture and laboratory exercises, with an emphasis on practical techniques and hands-on experience of recombinant protein purification. The course will cover a variety of expression systems, including prokaryotic and eukaryotic cells, and address traditional and new methods in protein purification.

Max Credits: 4
Min Credits: 4

81.469 Molecular Biology

Course ID: 7525

Course Details: Laboratory experiments and independent projects designed to illustrate current techniques and instrumentation used in genetic engineering. Included are restriction mapping, cloning, plasmid purification, blot hybridization, PCR, and DNA sequencing. Students are introduced to computer software utilized for DNA sequence analysis and manipulation.

Max Credits: 4
Min Credits: 4

81.497 Directed Study: Biological Science

Course ID: 7534

Course Details:
Max Credits: 1
Min Credits: 1

81.499 Directed Study: Biology

Course ID: 7535

Course Details:
Max Credits: 3
Min Credits: 3
82.354 Wildlife Management  
Course ID: 7608  
Course Details: Not suitable for credit towards any degree in the Division of Sciences.  
Max Credits: 3  
Min Credits: 3

83.327 Histology  
Course ID: 7631  
Course Details: Not suitable for credit towards any degree in the Division of Sciences.  
Max Credits: 3  
Min Credits: 3

85.430 Atmospheric Diffusion  
Course ID: 7790  
Course Details:  
Max Credits: 3  
Min Credits: 3

88.103 General Geology Laboratory  
Course ID: 7874  
Course Details:  
Max Credits: 3  
Min Credits: 3

89.5CO-OP Curricular Practical Training  
Course ID: 38047  
Course Details: Curricular Practical Training  
Max Credits: 1  
Min Credits: 0

89.198 Rocks  
Course ID: 7893  
Course Details:  
Max Credits: 3  
Min Credits: 3

89.307 Earth Materials I  
Course ID: 38083  
Course Details: An introduction to the basic principles that control the arrangement of atoms in crystalline solids (minerals) and their physical and chemical properties. Topics include crystal chemistry, crystal symmetry, macroscopic mineral identification, and the use of polarizing light microscopy and X-ray diffraction to identify and characterize minerals.  
Max Credits: 3
**89.308 Earth Materials II**

Course ID: 38072

Course Details: Origin and properties of igneous, metamorphic, and sedimentary rocks. The rock cycle is used as a unifying concept. The role of rock properties in environmental, economic, and engineering applications is considered.

Max Credits: 3
Min Credits: 3

**89.309 Earth Materials I Laboratory**

Course ID: 38084

Course Details: Laboratory to accompany Earth Materials I lecture. Topics include crystal structures, crystal symmetry, hand-specimen identification of minerals, X-ray diffraction, and polarizing light microscopy.

Max Credits: 1
Min Credits: 1

**89.310 Earth Materials II Lab**

Course ID: 38073

Course Details: Macroscopic and microscopic characterization and classification of rocks. Investigation of physical processes and spatial representation of rock and sediment distribution.

Max Credits: 1
Min Credits: 1

**89.319 Earth Surface Processes**

Course ID: 38074

Course Details: A study of the physical and chemical processes that create landforms on the Earth's surface. Emphasis is placed on physical and chemical weathering, fluvial erosion, glacial processes, soil formation, mass movements, slope stability and tectonic geomorphology.

Max Credits: 3
Min Credits: 3

**89.321 Earth Surface Processes Laboratory**

Course ID: 38075

Course Details: Hands-on investigation of landforms and surficial processes through interpretation and synthesis of maps, aerial photography and field data.

Max Credits: 1
Min Credits: 1

**89.331 Earth History**

Course ID: 38076

Course Details: An introduction to the history of the Earth and its life over the last 4.6 billion years. Applications include geologic principles, earth material, depositional environments, stratigraphy, the geological timescale, plate tectonics, and evolutionary theory.

Max Credits: 3
Min Credits: 3

**89.333 Earth History Laboratory**
Course ID: 38077

Course Details: This laboratory compliments Earth History lecture material. Exercises include stratigraphic methods, geologic maps and fossil identification.

Max Credits: 1
Min Credits: 1

89.341 Environmental and Engineering Geology

Course ID: 37928

Course Details: Fundamentals of geology applied to environmental and engineering problems. Topics include minerals and rocks, soil properties, rock mechanics, active tectonics and earthquake hazards, slope stability and landslides, groundwater, rivers and flood hazards, coastal processes, and site assessment. Student project.

Max Credits: 3
Min Credits: 3

89.491 Directed Study: Geoscience

Course ID: 7921

Course Details: The student, through regular and frequent consultation with the instructor, undertakes independent study of a particular area of the geosciences.

Max Credits: 3
Min Credits: 1

91.108 Intro to App Des & Mobile Comp

Course ID: 38246

Course Details: This course is an introduction to design principles of applications ("apps") that run on mobile devices (smart phones and tablet computers). The course will focus on the elements of graphic communication, software interaction design, and computational thinking. Students will gain theoretical knowledge and design skills in these domains by building a series of apps that run on the Android platform using MIT App Inventor software. The course will also include discussion of societal impacts of computing.

Max Credits: 3
Min Credits: 3

91.422 Machine Learning

Course ID: 8106

Course Details: This introductory course gives an overview of machine learning techniques used in data mining and pattern recognition applications. Topics include: foundations of machine learning, including statistical and structural methods; feature discovery and selection; parametric and non-parametric classification; supervised and unsupervised learning; use of contextual evidence; clustering, recognition with strings; small sample-size problems and applications to large datasets.

Max Credits: 3
Min Credits: 3

92.122SI Management Calculus Supplemental Instruction

Course ID: 36827

Course Details: Taken simultaneously with 92.122, this 1-credit course offers students, who are either retaking 92.122 or have completed 92.121 with a D or D+ grade, supplemental instructions to foster a greater opportunity for successful completion of Management Calculus. The course credit cannot be used to satisfy the credits required for graduation, but may be used to satisfy credits required for full time student status.

Max Credits: 1
Min Credits: 1
92.129SI Calculus IB Supplemental Instruction
Course ID: 38196
Course Details:
Max Credits: 1
Min Credits: 1

92.139 Calculus for the Life Sciences II
Course ID: 38100
Max Credits: 4
Min Credits: 4

92.217 Diff Essentials For Chemical Engineers
Course ID: 8278
Course Details:
Max Credits: 4
Min Credits: 4

95.373 Advanced Theory of Solids
Course ID: 8559
Course Details:
Max Credits: 3
Min Credits: 3

95.385 MCNP for Radiological Sciences
Course ID: 36151
Course Details: This course provides the theory and application of the Monte Carlo N-Particle (MCNP) radiation transport computer code to radiological sciences and protection, with emphasis on radiation dosimetry and shielding, and criticality problems (offered as 98.585 for graduate credit)
Max Credits: 3
Min Credits: 3

95.465 Physics of Radiation Oncology
Course ID: 36152
Course Details: This course provides the theory and application of the physical concepts that pertain to radiation oncology, with emphasis on radiation treatment planning for linear accelerators and brachytherapy sources, photon and electron dose assessment, and recent experimental treatment modalities. (offered as 98.565 for graduate credit)
Max Credits: 3
Min Credits: 3

96.402 Radiation Safety and Control II
Course ID: 8802
Course Details: This course provides a continuation of the theoretical and practical aspects of radiation protection provided in Radiation Safety and Control I (98.501). Topics include the statistical analyses and data reduction techniques that are used to analyze radiation measurements pertaining to the field of radiation protection. Laboratory sessions on alpha and gamma radiation measurements and air sampling will reinforce class lectures. Students also will experience applied radiation protection and dose assessment through a contamination control exercise that involves the use of protective clothing and respiratory protection.

Max Credits: 4
Min Credits: 3

98.401 Radiological Safety and Control I

Course ID: 1209

Course Details: This course provides a theoretical basis for radiological sciences and protection, with a rigorous review of the fundamentals of radiation physics including nuclear reactions, radioactivity and the kinetics of radioactive decay, natural and man-made radiation sources, the characteristics of ionizing radiation, radioactivity analysis, radiation dose quantities and measurement, external and internal radiation dosimetry, and radiation protection techniques.

Max Credits: 4
Min Credits: 3

98.462 Special Topics in Radiological Sciences

Course ID: 8799

Course Details:

Max Credits: 3
Min Credits: 3

98.481 Mathematical Methods of Radiological Sciences

Course ID: 1207

Course Details: This course provides an overview of applied mathematical concepts that are useful in radiological sciences and protection, including special techniques for radiation physics, radiation dosimetry, and radiation shielding, with emphasis on computer applications.

Max Credits: 3
Min Credits: 3

81.595-I Immunology Laboratory

Course ID: 36657

Course Details: A series of basic laboratory exercises dealing with the preparation, isolation and characterization of antigens, antibodies and effector cells.

Max Credits: 2
Min Credits: 2

84.115 Principles of Chemistry

Course ID: 7638

Course Details: The course provides an introduction to the basic concepts of Chemistry with an emphasis on critical thinking, problem-solving, and computational skills required for more advanced Chemistry courses. Topics include measurement, chemical calculations, problem solving logic, units analysis, chemical reactions, the periodic table, basic bonding theory and solutions. No previous Chemistry experience is assumed. There is no lab component to this course.

Max Credits: 3
Min Credits: 3

84.360 The Responsible Chemist
Course Details: This course is required of chemistry majors and addresses ethical, regulatory, and environmental aspects of their profession. Students are exposed to a wide range of research integrity issues that include TSCA (Toxic Substance Control Act), SOPs (Standard Operating Procedures) and quality management. Compliance issues include an overview of OSHA (Occupational Safety and Health Administration) and EPA (Environmental Protection Agency), as well as an introduction to patent law. The importance of maintaining integrity in their discipline is emphasized, and case studies are presented for study and discussion.

Max Credits: 3
Min Credits: 3

91.103 Computing I Lab

Course Details: This is the lab class for 91.101 Computing I. This class must be taken with 91.101 Computing I in the same semester.

Max Credits: 1
Min Credits: 1

91.104 Computing II Lab

Course Details: This is a lab class for 91.102 Computing II. This class must be taken with 91.102 Computing II in the same semester.

Max Credits: 1
Min Credits: 1

91.480 Honors Project I

Course Details: This course provides an undergraduate research experience for Computer Science majors enrolled in the Honors Program. Each student develops a project idea in consultation with the instructor. The student writes a proposal for the project, reads the relevant literature, performs the project, writes a project report or thesis, and makes an oral presentation about the project.

Max Credits: 3
Min Credits: 3

92.102 Freshman Seminar in Mathematics

Course Details: This course is designed to orient undergraduate math majors to the university and to their chosen field. Students will learn about the mathematics program, the mathematics faculty and their research interests, careers in math-related areas, internship opportunities, and university resources.

Max Credits: 1
Min Credits: 1

81.420 Biochemistry II

Course Details: This course will focus on protein dynamics where students will gain facility with thermodynamics of protein folding/misfolding, catalysis, kinetics and binding equilibria as they apply to proteins and other molecules in biological systems. The central theme of this course is that living systems can be understood in terms of the fundamental principles defining the structure and energetics of biological molecules. Attention will be given to quantitative aspects of enzyme kinetics and molecular binding. Examples of how these principles apply to the understanding and treatment of human disease will be discussed.

Max Credits: 3
Min Credits: 3
91.493 Cooperative Education in Computer Science

Course ID: 38490

Course Details: Supervision of cooperative educational experiences in Computer Science.

Max Credits: 1
Min Credits: 1

95.141SI Supplemental Instruction for Physics I - Navitas Only

Course ID: 38492

Course Details: Supplemental Instruction for Physics I - Navitas Students Only.

Max Credits: 1
Min Credits: 1

89.325 Geology for Engineers

Course ID: 38517

Course Details: This course will introduce basic geological principles with an emphasis on engineering applications. Topics covered include minerals and rocks and their properties, surface processes, earthquakes and rock deformation, dynamic processes that affect the earth's surface, geological hazards and their mitigation, earth resources.

Max Credits: 3
Min Credits: 3

92.496 Mathematics Practicum

Course ID: 38533

Course Details: Unpaid internship in the Department of Mathematical Sciences. This allows students to receive up to 3 (free elective) credits while working on an approved project. Students who have a position and who wish to date advantage of this Practicum should complete and submit the attached form to the department Internship Coordinator.

Max Credits: 3
Min Credits: 1

82.4ACE Cooperative Education Experience

Course ID: 38647

Course Details: This zero credit course is specifically designated for College of Science students who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program, and have secured a third, full-time co-op employment experience. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

91.402 Software Project II

Course ID: 8094

Course Details: A continuation of 91.401. Students must submit a proposal to the directing faculty member, obtain his/her signed approval, and forward a copy of the signed proposal to the department chairperson.

Max Credits: 3
Min Credits: 3
91.481 Windows Practicum/Internship

Course ID: 8129

Course Details: In this course, students continue and complete the project started in 91.480 Honors Project I.

Max Credits: 3
Min Credits: 3

92.302 Introduction to Applied Mathematics II

Course ID: 8304


Max Credits: 3
Min Credits: 3

95.417 Space Science Mission Design

Course ID: 38608

Course Details: This one-semester, 3-credit course intended for junior level science and engineering majors, is centered around the conceptual design of a spaceflight mission. In this project-based and team-based class, students will apply their science and technical knowledge to develop a spacecraft and mission concept tailored to answer a specific science question. Students will perform quantitative trade studies consistent with real-life constraints such as cost, schedule, manufacturability, team-expertise, operational environment, mission lifetime, etc. Students will 1) learn the fundamentals of key subsystems involved in a space flight mission and 2) apply their skills of inquiry, research, critical thinking to design a complete space science mission to solve a real-world problem while working within a multidisciplinary team.

Max Credits: 3
Min Credits: 3

95.456 Radiative Processes in Astrophysics

Course ID: 38579

Course Details: Our knowledge of the universe beyond the Solar System is derived almost entirely from our interpretation of the radiation we receive from the universe; Our knowledge of the Earth's upper atmosphere and the atmospheres of other solar system objects is heavily dependent on observations of electromagnetic radiation. To understand the atmospheres of Earth and other planets, stars, galaxies and the universe, we need to understand the processes which produce electromagnetic radiation, and how radiation interacts with matter and propagates through space. This course describes the basic processes which create and alter such electromagnetic radiation before it's detected here in the Solar System. The course will consist of a combination of lectures, problem sets and class discussion sessions. The lectures will be expanded from the material in the text and will include additional material on the astrophysical and planetary context of radiative processes, drawn primarily from the following list of references. The discussion sessions will often be based on recent problem sets - regular participation of students in class discussions is expected.

Max Credits: 3
Min Credits: 3

95.464 Particle Astrophysics

Course ID: 38580

81.342 Comp Vertebrate Anatomy

Course ID: 7501

Course Details: This course is designed to provide students a broad understanding of the anatomy of vertebrates with an emphasis on comparison between taxa and their evolutionary significance. Students will acquire knowledge and understanding of anatomical structure and terminology of vertebrates and an understanding of how these structures have evolved from ancestral forms. There will also be some reference to the fields of embryology, histology and paleontology in the course. This course may interest students who might want to go into various animal/human focused fields (e.g. veterinary science, medicine or graduate studies with more organismal focus), and students who simply want a course focused on vertebrates. However, students should note that this course does not focus on human nor veterinary anatomy. This course could also help undergraduates in the General Biology and Ecology Option satisfy free elective requirements.

Max Credits: 3
Min Credits: 3

85.301 Atmospheric Thermodynamics

Course ID: 7774


Max Credits: 3
Min Credits: 3

85.495 Honors Research: Atmospheric Science

Course ID: 7794

Course Details: An individual or team research project carried out by qualified students with the approval of and supervision by a faculty member.

Max Credits: 3
Min Credits: 3

87.495 Honors Research: Environmental Studies

Course ID: 38727

Course Details: An individual or team research project carried out by qualified students with the approval of and supervision by a faculty member.

Max Credits: 3
Min Credits: 3

89.495 Honors Research: Geoscience

Course ID: 7922

Course Details: An independent scientific research project carried out by a qualified senior under the supervision of a faculty member.

Max Credits: 3
Min Credits: 3

91.423 Computer Vision I

Course ID: 38743
Course Details: Computer vision has seen remarkable progress in the last decade, fueled by the ready availability of large online image collections, rapid growth of computational power, and advances in representations and algorithms. Applications range from 3-D scene reconstruction, to visual Simultaneous Localization and Mapping (SLAM) for robotics, to real-time human body pose estimation. This introductory computer vision course explores various fundamental topics in the area, including the principles of image formation, local feature analysis, segmentation, multi-view geometry, image warping and stitching, structure from motion, and object recognition.

Max Credits: 3
Min Credits: 3

84.223 Organic Chemistry IIIB

Course ID: 7657

Course Details: The course covers the chemical and mechanistic principles of organic reactions utilized in biological systems. Spectroscopy, organic reactions and related mechanisms of bio-molecules or small molecules in biological systems will be discussed from a functional group perspective. Multiple examples from medicinal chemistry, chemical biology and biochemistry will be used to illustrate the concepts. Knowledge of organic mechanistic arrow-pushing formalism is required.

Max Credits: 3
Min Credits: 3

85.325 Weather Communications

Course ID: 38852

Course Details: An introduction to the field of weather communication. Topics will include the basic principles of communicating weather forecasts, television and radio broadcasting, written communication of weather, the use of social media applications, and applied forecasting techniques. Individual and group projects utilizing commercial broadcast facilities.

Max Credits: 3
Min Credits: 3

85.493 Internship: Atmospheric Science

Course ID: 38853

Course Details: Work experience with private or public employer. Written report and supervisor evaluation required.

Max Credits: 3
Min Credits: 1

87.493 Internship: Environmental Studies

Course ID: 38854

Course Details: Work experience with private or public employer. Written report and supervisor evaluation required.

Max Credits: 3
Min Credits: 1

89.493 Internship: Environmental Geoscience

Course ID: 38855

Course Details: Work experience with private or public employer. Written report and supervisor evaluation required.

Max Credits: 3
Min Credits: 1

91.442 Natural Language Processing

Course ID: 38884

Course Details: This course introduces principles and techniques behind natural language processing (NLP), and covers a large selection of important automatic text processing tasks. Selected topics include n-gram language models, part-of-speech tagging,
statistical parsing, word sense disambiguation, discourse segmentation, information extraction, sentiment analysis, machine translation. Quantitative techniques are emphasized, with a focus on applying statistical models to large collections of text. The course provides students with a hands-on experience in building a substantial NLP application of their choice.

Max Credits: 3
Min Credits: 3

92.232 Math Lab I

Course ID: 31891

Course Details: An introduction to mathematics related software. Topics from Calculus & Differential Equations will be explored using a symbolic package like Maple. the course will also introduce LaTeX, the standard for typesetting mathematics.

Max Credits: 1
Min Credits: 1

92.272 Introduction to Programming with MATLAB

Course ID: 38929

Course Details: This course will introduce basic programming concepts using MATLAB as the programming environment. Topics include an introduction to MATLAB, array manipulation, graphics, script files, data input and output, relational and logical operators, conditional statements, loops, and iterative procedures. Additional topics will be discussed as time permits. Additional topics will be chosen from the following: finding roots of nonlinear equations, random number generation, Markov processes, simple statistics, interpolation, and the basics of Fourier analysis.

Max Credits: 3
Min Credits: 3