Materials Science is an interdisciplinary field which combines microscopic physics and chemistry in order to understand and control the properties of materials such as plastics, semiconductors, metals, liquid crystals, and biomaterials. Williams students with an interest in the properties of materials or in pursuing careers in materials science or a variety of engineering disciplines would benefit from following the courses in this program.

MTSC Courses

CHEM 336  (S)  Materials Chemistry
Materials Science focuses on the study of bulk physical properties such as hardness, electrical conductivity, optical behavior, and elasticity. Materials chemists bridge the gap between traditional synthetic chemists and materials scientists, by working to understand the relationships between bulk physical properties, length scale (mesoscale, nanoscale), and molecular structure. This course will cover a variety of different types of materials and their properties including solids (insulators, semiconductors, conductors, superconductors, magnetic materials), soft materials (polymers, gels, liquid crystals), nanoscale structures, and organic electronics. We'll examine some of the latest developments in materials chemistry, including new strategies for the synthesis and preparation of materials on different length scales, as well as a variety of potential applications of emerging technologies.

Class Format: three hours per week
Requirements/Evaluation: problem sets, reviews of research articles, hour exams, and a final exam
Prerequisites: CHEM 155 or 256 and 251/255
Enrollment Limit: 24
Expected Class Size: 16
Grading: no pass/fail option, yes fifth course option
Distributions: (D3)
Attributes: MTSC Courses

Spring 2020
LEC Section: 01    TR 8:30 am - 9:45 am    Lee Y. Park

CHEM 348  (F)  Polymer Chemistry
From synthetic to natural macromolecules, we encounter polymers everywhere and everyday. This course explores the multitude of synthetic techniques available and discusses how structure defines function. Topics include condensation and chain (anionic, cationic, radical) polymerizations, dendrimers, controlling molecular weight, ring opening, and biopolymer syntheses. Fundamentals of composition and physical properties of polymers, and methods of characterization are also covered.

Class Format: three hours per week
Requirements/Evaluation: problem sets, participation, two exams, and a final project
Prerequisites: CHEM 251/255
Enrollment Limit: 19
Enrollment Preferences: Chemistry majors
Expected Class Size: 19
Grading: yes pass/fail option, yes fifth course option
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives  MTSC Courses
CHEM 364 (S) Instrumental Methods of Analysis

Cross-listings: ENVI 364 CHEM 364

Primary Cross-listing

This course provides the student an understanding of the applicability of current laboratory instrumentation both to the elucidation of fundamental chemical phenomena and to the measurement of certain atomic and molecular parameters. Student will gain knowledge and understanding of the theory and practical use of a variety of instrumental techniques; including, but not limited to, chromatography, mass spectrometry, thermal methods, electroanalytical techniques, atomic and molecular absorption and emission spectroscopy, X-ray diffraction, and optical and electron microscopies, with examples drawn from the current literature. Analytical chemical and instrumental techniques will be developed in the lecture and extensively applied within the laboratory. These skills are useful in a wide variety of scientific areas. Through exploration of primary literature and review articles we will discuss recent developments in instrumental methods and advances in the approaches used to address modern analytical questions.

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

Requirements/Evaluation: class participation, 2 exams, problem sets, oral presentations and discussions of selected topics, and an independent project

Prerequisites: CHEM 155 or 256 and 251/255; may be taken concurrently with CHEM 256 with permission of instructor

Enrollment Limit: 9 per lab

Expected Class Size: 9 per lab

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

Distributions: (D3)

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

ENVI 364 (D3) CHEM 364 (D3)

Attributes: BIMO Interdepartmental Electives ENVI Natural World Electives EVST Methods Courses MTSC Courses

GEOS 202 (S) Mineralogy

This course could be subtitled “An Introduction to Earth Materials and Analytical Techniques.” As the basis for all subsequent solid-earth courses in the major, it provides a systematic framework for the study of minerals—Earth’s building blocks: their physical and chemical properties at all scales and the common analytical methods used to identify and interpret them. The course progresses from hand-specimen morphology and crystallography through element distribution and crystal chemistry to the phase relations, compositional variation, and mineral associations within major rock-forming mineral systems. Laboratory work includes the determination of crystal symmetry; mineral separation; the principles and applications of optical emission spectroscopy; wavelength- and energy-dispersive x-ray spectrochemical analysis; x-ray diffraction; the use of the petrographic microscope; and the identification of important minerals in hand specimen and thin section.

Class Format: lecture three hours per week and laboratory three hours per week; independent study of minerals in hand specimen; one afternoon field trip

Requirements/Evaluation: one hour test, lab work, and a final exam

Prerequisites: one 100-level GEOS course or permission of instructor

Enrollment Limit: 14
Enrollment Preferences: sophomores and juniors planning to take GEOS 301, 302 and/or 303 in the subsequent year

Expected Class Size: 12

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

Distributions: (D3)

Attributes: EXPE Experiential Education Courses GEOS Group C Electives - Solid Earth MTSC Courses

Spring 2020

LAB Section: 02  T 1:00 pm - 4:00 pm  Bud Wobus

LEC Section: 01  TR 8:30 am - 9:45 am  Bud Wobus

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

Cross-listings: PHYS 234  GEOS 234

Secondary Cross-listing

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

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

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

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

Enrollment Limit: 20

Enrollment Preferences: based on students' scientific background and seniority

Expected Class Size: 10

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

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

Distributions: (D3) (QFR)

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

Attributes: MTSC Courses

Spring 2020

LEC Section: 01  MR 1:10 pm - 2:25 pm  Katharine E. Jensen

PHYS 451 (S) Condensed Matter Physics (QFR)

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

Requirements/Evaluation: weekly readings and problem sets, and exams

Prerequisites: PHYS 301, PHYS 302 (may be taken simultaneously) preferred; or permission of instructor

Enrollment Limit: 10

Enrollment Preferences: Physics majors
Expected Class Size: 4-6

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

Distributions: (D3) (QFR)

Attributes: MTSC Courses

Not offered current academic year