MATERIALS SCIENCE STUDIES (Div III)

Advisory Committee: Professors: D. Aalberts, S. Goh, L. Park. Assistant Professor: K. Jensen.

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 (F) Materials Chemistry

Materials have defined much of what is possible in our daily lives. Materials scientists are at the center of imagining and delivering progress, as they improve existing materials and develop new ones to meet today's needs. Materials science focuses on the relationships between the structure, processing, properties, and performance of materials. In this course, we will explore how the properties and potential applications of a solid are related to its atomic and molecular structure, as well as to its organization on larger length scales than are traditionally considered in chemistry. We will cover a variety of different types of materials including metals, ceramics, polymers, and composites. We will examine some of the latest developments in materials science, including new strategies for the synthesis 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, two exams, and oral presentations

Prerequisites: CHEM 155 or 256 and 251/255

Enrollment Limit: 20

Enrollment Preferences: Chemistry majors

Expected Class Size: 20

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

Distributions: (D3)

Attributes: MTSC Courses

Fall 2021

LEC Section: 01 TR 9:55 am - 11:10 am Amnon G Ortoll-Bloch

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

Requirements/Evaluation: weekly literature discussions, two exams, and a final project

Prerequisites: CHEM 251/255

Enrollment Limit: 12

Enrollment Preferences: Chemistry majors

Expected Class Size: 12

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

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives MTSC Courses

Not offered current academic year

CHEM 364 (S) Instrumental Methods of Analysis

Cross-listings: ENVI 364 CHEM 364

Primary Cross-listing

Instrumental methods of analysis provide scientists with different lenses to observe and elucidate fundamental chemical phenomena and to measure parameters and properties at the atomic, molecular, and bulk scales. This course introduces a framework for learning about a variety of instrumental techniques that typically include chromatography, mass spectrometry, thermal methods, atomic and molecular absorption and emission spectroscopy, X-ray diffraction, and optical and electron microscopies. Students complete two 5-6 week long laboratory projects and gain hands-on experience and project planning skills to study molecules and materials of interest. This practical experience is complemented by lectures that cover the theory and broader applications of these techniques. Students also explore the primary literature and highlight recent advances in instrumental methods that address today's analytical questions. The skills learned are useful in a wide variety of scientific areas and will prepare you well for research endeavors.

Class Format: lecture, two times per week and laboratory, four hours per week; periodic small group meetings to plan laboratory research projects

Requirements/Evaluation: Weekly data analysis and project planning assignments for laboratory and analysis of readings for class, problem sets, two project reports and presentations, one oral presentation of an application of instrumental methods, a final independent literature project and presentation; demonstrated progress in research skills, and project engagement.

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

Enrollment Limit: 8/lab

Enrollment Preferences: Chemistry and Environmental Studies majors

Expected Class Size: 16

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

Spring 2022

LAB Section: 03 T 1:00 pm - 5:00 pm Christopher Goh

LEC Section: 01 TR 9:55 am - 11:10 am Christopher Goh

LAB Section: 02 M 1:00 pm - 5:00 pm Christopher Goh

LEC Section: 01 TR 9:55 am - 11:10 am Christopher Goh

LAB Section: 03 T 1:00 pm - 5:00 pm Christopher Goh

LAB Section: 02 M 1:00 pm - 5:00 pm Christopher Goh

GEOS 202 (F) 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. This course is in the Solid Earth group for the Geosciences major.

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: yes pass/fail option, no fifth course option

Distributions: (D3)

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

Not offered current academic year

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

Cross-listings: GEOS 234 PHYS 234

Secondary Cross-listing

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

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

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

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

Enrollment Limit: 20

Enrollment Preferences: based on students' scientific background and seniority

Expected Class Size: 10

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

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

Distributions: (D3) (QFR)

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

GEOS 234 (D3) PHYS 234 (D3)

Attributes: MTSC Courses

Not offered current academic year

PHYS 451 (F) Condensed Matter Physics

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

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

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

Enrollment Limit: 10

Enrollment Preferences: Physics majors

Expected Class Size: 4-6

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

Distributions: (D3)

Attributes: MTSC Courses

Fall 2021

SEM Section: 01 MR 1:10 pm - 2:25 pm Daniel P. Aalberts