

CHEMISTRY AND PHYSICS

Chair: Tsanangurayi Tongesayi, Department of Chemistry and Physics

Our curricula provide foundations in the traditional chemistry sub-disciplines. The programs serve as excellent preparation for further professional study in chemistry and related sciences, health professions such as medicine, dentistry, pharmacy, and physical therapy. Careers in academia, the chemical and pharmaceutical industries, environmental protection, forensics, government, industrial hygiene, information science, patent law, science writing, toxicology, and education are open to those whose initial field of study is chemistry.

The Bachelor of Science in Chemistry (CE.BS) provides a core curriculum of chemistry while allowing sufficient flexibility to combine it with a second major, a minor, or elective biology courses for pre-medical studies, within the total number of credits required for graduation. Completion of the Chemistry and Education curriculum qualifies graduates to apply for Secondary Education endorsement as a chemistry teacher. Completion of two additional courses provides eligibility for physical science certification, which is required for teaching chemistry or physics at the high school level.

The Bachelor of Science in Chemistry with a concentration in Advanced Chemistry (CE.ACS.BS) provides a strong foundation in all five of the chemistry sub-disciplines. Students planning to pursue graduate study in chemistry should follow this program, which leads to a degree certified by the American Chemical Society.

The Bachelor of Science in Chemistry with a track in Biochemistry (CE.BIO.BS) includes an introduction to the traditional subject areas of biology as well as specific biochemistry courses. This program is appropriate for students planning to seek employment or pursue graduate study in chemistry/biochemistry, or attend medical or other health professional schooling. The Industry track (CE.IND.BS) is designed for students who are interested in direct entry into the workforce. Such students can still pursue graduate studies in chemistry or health-related professional schooling. American Chemical Society certification may be achieved in these two tracks by appropriate choice of electives.

The Chemistry faculty are engaged in research in many interesting areas. Providing opportunities for student participation in these efforts is an important priority for the department.

Departmental Honors can be earned in Chemistry if the following criteria are met*:

- An overall GPA of 3.5 or higher;
- A major GPA of 3.7 or higher;
- At least three credits of research;
- Completion of all five foundation courses in the five major areas of chemistry;
- Completion of *at least three in-depth courses* from the five major areas of chemistry;
- Public presentation of research.

**Please speak to a department advisor for more details.*

Programs Majors

- B.S. in Chemistry (<http://catalog.monmouth.edu/undergraduate-catalog/science/chemistry-physics/chemistry-bs/>)
- B.S. in Chemistry and Education with Endorsement in Secondary Education in Chemistry (<http://catalog.monmouth.edu/undergraduate-catalog/science/chemistry-physics/chemistry-education-bs-endorsement-secondary-education-chemistry/>)
- B.S. in Chemistry and Education with Endorsement in Secondary Education in Physical Science (<http://catalog.monmouth.edu/undergraduate-catalog/science/chemistry-physics/chemistry-education-bs-endorsement-secondary-education-physical-science/>)
- B.S. in Chemistry with a Concentration in Advanced Chemistry (ACS Approved) (<http://catalog.monmouth.edu/undergraduate-catalog/science/chemistry-physics/chemistry-bs-concentration-advanced-chemistry-accs-approved/>)

Minor

- Chemistry (<http://catalog.monmouth.edu/undergraduate-catalog/science/chemistry-physics/chemistry-minor/>)

Faculty

Warren Brown, Lecturer. B.S., M.S, Ph.D., Georgia State University
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Azzam Elayan, Lecturer. Ph.D., Wesleyan University. Organometallic chemistry. Mechanisms of metal-catalyzed processes, particularly those involving carbon-carbon bond-forming reactions.
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Ilyong Jung, Assistant Professor. B.S., M.S., Kyngpook National University; Ph.D., Brown University. Research interests include Biophysics of microorganism locomotion.
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Massimiliano Lamberto, Professor. B.S., M.S., University of Messina, Italy; Ph.D., University of Southampton (UK). Organic chemistry. Research interests: small molecule synthesis for the inhibition of telomerase by G-quadruplex DNA stabilization; synthesis of novel chromophoric systems for dye-sensitized solar cells and sensor applications; synthetic methodology.
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Gregory Moehring, Associate Professor. B.A., Western Washington University; Ph.D., Purdue University. Research interests are synthesis and NMR characterization of transition metal polyhydride

compounds; transformations of small molecules at transition metal polyhydride compounds.
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Datta V. Naik, Professor. B.S.c., St. Xavier's College, University of Bombay, Goa, India; Ph.D., University of Notre Dame. Analytical inorganic chemistry.
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William Schreiber, Lecturer and Coordinator, Clinical Laboratory Sciences and Medical Laboratory Science Programs. B.S., Massachusetts Institute of Technology; Ph.D., University of Rochester. Organic chemistry. Organic synthesis, process research, and chemical education.
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Danuta Szewajka, Senior Lecturer. M.S., Technical University of Warsaw; M.S., University of Rochester; Ph.D., Rutgers University. Biophysical chemistry. Chemistry of proteins and nucleic acids, thermodynamics of drug binding to DNA.
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Tsanangurayi Tongesayi, Professor and Chair. B.S., M.S., University of Zimbabwe; Ph.D., West Virginia University. Analytical chemistry. Research interests are speciation, geochemical cycling, bioavailability of heavy metals in the environment, technologies and methods for the removal of toxic heavy metals and their compounds from drinking water, and analytical method development.
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Courses

CE-101 Chemistry in Our Lives

Credits: 3

Term Offered: All Terms

Course Type(s): NS

Major concepts and methodologies in chemistry and their relation to specific, important issues in today's society.

CE-109 Introduction to General, Organic, and Biochemistry

Credits: 4

Prerequisite(s): Score of 3 or higher on the Mathematics Placement Exam, or MA-105 passed with a grade of C- or higher.

Course Type(s): None

Structure of matter, the mole concept, chemical bonds and reactions, acids and bases, structure and reactions of organic compounds, chemistry and metabolism of amino acids, carbohydrates, lipids, proteins, and nucleic acids. Three hours of class, three hours of lab per week. Students must have had High School Chemistry to take this course.

CE-111 General Chemistry I

Credits: 3

Prerequisite(s): Score of 2 or higher on the Mathematics Placement Exam or MA-050 passed with a grade of C- or higher

Co-requisite(s): CE-111L

Term Offered: All Terms

Course Type(s): NS

The first of two lecture courses which, taken together, provide a preparation for subsequent courses in chemistry. Principles and theories of chemical problem solving, stoichiometry and chemical reactions, states of matter, periodic properties of the elements, atomic and molecular structure, introductory quantum mechanics, thermochemistry, and the properties of gases are covered.

CE-111L General Chemistry I Laboratory

Credits: 1

Co-requisite(s): CE-111

Term Offered: All Terms

Course Type(s): None

Laboratory work to complement the class work of CE-111 and CE-112; review of mathematical fundamentals; experiments involving observation and interpretation of chemical and physical changes; experimental studies of gas laws, thermodynamics, kinetics, equilibrium, acids and bases, qualitative analysis, and molecular mass determination. Three hours per week.

CE-111R General Chemistry I Recitation

Credits: 1

Co-requisite(s): CE-111 and CE-111L

Term Offered: All Terms

Course Type(s): None

Gen Chem 1 Recitation supports General Chemistry 1 students with active learning activities such as group problem solving and peer-led team learning that focus on the key or most challenging aspects of the General Chemistry 1 course. Assessment activities, including quizzes, are included in Gen Chem 1 Recitation. Gen Chem 1 is a Pass/Fail corequisite for CE 111 - General Chemistry 1. Corequisite: CE-111 and CE-111L

CE-112 General Chemistry II

Credits: 3

Prerequisite(s): CE-111 passed with a grade of C- or higher, CE-111L passed with a grade of C- or higher, and either MA-101 passed with a grade of C- or higher or a score of 3 or higher on the Mathematics Placement Exam.

Co-requisite(s): CE-112L

Term Offered: All Terms

Course Type(s): NS

The second of two lecture courses which, taken together, provide preparation for subsequent courses in chemistry. Properties of liquids and solutions, chemical kinetics and equilibrium, thermodynamics, electrochemistry and nuclear chemistry.

CE-112L General Chemistry II Laboratory

Credits: 1

Co-requisite(s): CE-112

Course Type(s): None

Laboratory work to complement the class work of CE-111 and CE-112; review of mathematical fundamentals; experiments involving observation and interpretation of chemical and physical changes; experimental studies of gas laws, thermodynamics, kinetics, equilibrium, acids and bases, qualitative analysis, and molecular mass determination. Three hours per week.

CE-112R General Chemistry II Recitation**Credits: 1**

Prerequisite(s): CE-111 and CE-111L both passed with a grade of C- or higher; CE-111R.

Co-requisite(s): CE-112 and CE-112L

Term Offered: All Terms

Course Type(s): None

Chem 2 Recitation supports General Chemistry 2 students with active learning activities such as group problem solving and peer-led team learning that focus on the key or most challenging aspects of the General Chemistry 1 course. Assessment activities, including quizzes, are included in Gen Chem 2 Recitation. Gen Chem 2 Recitation is a Pass/Fail corequisite for CE-112.

CE-198 Special Topics in Chemistry (100 Level)**Credits: 1-3**

Course Type(s): None

An intensive study of a particular subject or problem in chemistry to be announced prior to registration. May be conducted on either a lecture-discussion or a seminar basis. If a prerequisite is required it will be announced in the course schedule.

CE-220 Environmental Chemistry**Credits: 3**

Prerequisite(s): CE-112 and CE-112L, both passed with a grade of C- or higher

Co-requisite(s): CE-220L

Course Type(s): MEBP

Soil, aquatic, and atmospheric chemistry; environmental analytical chemistry; connections to environmental biology. Sources, reactions, mobility, effects, and fates of chemical species in the soil, water and air environments and the effect of human activity on these. Gives the theoretical principles and techniques of both classical and instrumental methods of chemical analysis.

CE-220L Environmental Chemistry Laboratory**Credits: 1**

Co-requisite(s): CE-220

Course Type(s): MEBP

Soil, aquatic and atmospheric chemistry; environmental analytical chemistry; connections to environmental biology. Sources, reactions, mobility, effects and fates of chemical species in the soil, water and air environments and the effect of human activity on these. Laboratory experiments and field trips will be used to address the needs for this course. Students will gain hands-on experience in both classical and instrumental methods of chemical analysis.

CE-221 Analytical Chemistry I Quantitative Analysis**Credits: 3**

Prerequisite(s): CE-112 and CE-112L both passed with a grade of C- or higher

Co-requisite(s): CE-221L

Term Offered: Spring Term

Course Type(s): None

Theoretical principles and techniques of volumetric, gravimetric, and potentiometric methods of analysis; treatment of analytical data, equilibria involving acid-base, redox, complexometric, and precipitation reactions.

CE-221L Analytical Chemistry I Laboratory Quantitative Analysis**Credits: 1**

Co-requisite(s): CE-221

Term Offered: Spring Term

Course Type(s): None

Laboratory techniques, procedures, and practice in quantitative analysis of selected substances by volumetric, gravimetric, and potentiometric methods.

CE-241 Organic Chemistry I**Credits: 3**

Prerequisite(s): CE-112 and CE-112L both passed with a grade of C- or higher

Co-requisite(s): CE-241L

Term Offered: All Terms

Course Type(s): None

Preparations and reactions of major classes of organic compounds with extensive discussion of reaction mechanisms and stereo-chemistry; interpretation of mass, infrared, and nuclear magnetic resonance spectra.

CE-241L Organic Chemistry I Laboratory**Credits: 1**

Prerequisite(s): CE-112 and CE-112L.

Co-requisite(s): CE-241

Term Offered: All Terms

Course Type(s): None

Laboratory work demonstrating the basic techniques of organic chemistry; qualitative organic analysis; and use of the gas chromatograph and infrared and nuclear magnetic resonance spectrometers to solve problems. Three hours per week.

CE-242 Organic Chemistry II**Credits: 3**

Prerequisite(s): CE-241 and CE-241L, both passed with a grade of C- or higher.

Co-requisite(s): CE-242L.

Term Offered: All Terms

Course Type(s): MEBP

Preparations and reactions of major classes of organic compounds with extensive discussion of reaction mechanisms and stereo-chemistry; interpretation of mass, infrared, and nuclear magnetic resonance spectra.

CE-242L Organic Chemistry II Laboratory**Credits: 1**

Prerequisite(s): CE-241 and CE-241L, both passed with a grade of C- or higher.

Co-requisite(s): CE-242.

Course Type(s): None

Laboratory work demonstrating the basic techniques of organic chemistry; qualitative organic analysis; and use of the gas chromatograph and infrared and nuclear magnetic resonance spectrometers to solve problems. Three hours per week.

CE-298 Special Topics in Chemistry (200 Level)**Credits: 1-3**

Prerequisite(s): CE-111, CE-111L, CE-112, CE-112L and others as announced in the course schedule

Course Type(s): None

An intensive study of a particular subject or problem in chemistry to be announced prior to registration. May be conducted in a lecture, seminar or laboratory format.

CE-299 Independent Study in Chemistry**Credits: 1-3**

Term Offered: Spring Term

Course Type(s): None

Original research work planned and carried out with the assistance of a faculty research advisor. The number of course credits will be arranged with the advisor. Three hours per credit. Prior permission of the directing professor and department chair is required to take this course.

CE-314 Chemical Literature and Seminar**Credits: 3**

Prerequisite(s): CE-241

Term Offered: All Terms

Course Type(s): RD

The course focuses on the professional development of chemistry majors including: the chemical literature and how to use it, presentation skills for chemists, laboratory safety, professional ethics, and intellectual property.

Prerequisite: CE-241

CE-322 Analytical Chemistry II**Credits: 3**

Prerequisite(s): CE-221, CE-221L, MA-116, PH-212, and PH-212L, all passed with a grade of C- or higher, or permission of the instructor.

Term Offered: Fall Term

Course Type(s): None

Basic components of instruments and their arrangements; fundamental principles, applications, and limitations of instrumental methods of chemical analysis; spectroscopic methods (UV-Visible, Fourier transform infrared, Raman, Fluorescence, Phosphorescence, Atomic absorption, Atomic emission, and Mass spectrometry); electrochemical methods (Potentiometry and Voltammetry); separation methods (High Performance liquid chromatography, Gas chromatography, and Capillary Electrophoresis).

CE-322L Analytical Chemistry II Laboratory**Credits: 2**

Co-requisite(s): CE-322

Term Offered: Fall Term

Course Type(s): WT

Basic components of instruments and their arrangements; fundamental principles, applications and limitations of instrumental methods of chemical analysis; spectroscopic methods (UV-Visible, Fourier transform infrared, Fluorescence, Atomic absorption and Atomic emission); electrochemical methods (Potentiometry and Voltammetry); separation methods (High Performance liquid chromatography, Gas chromatography - Mass spectrometry). Laboratory experiments and an independent research project will be used to address the needs of this course. Students will gain hands-on experience in instrumental methods of chemical analysis for both qualitative and quantitative work.

CE-325 NMR Spectroscopy**Credits: 3**

Prerequisite(s): CE-242L

Term Offered: Fall Term

Course Type(s): None

A treatment of the theories and applications of modern Fourier transform nuclear magnetic resonance (FT-NMR) spectroscopy. Applications of FT-NMR spectroscopy to the investigation and solution of chemical problems will be emphasized.

CE-333 Biochemistry**Credits: 3**

Prerequisite(s): CE-242

Co-requisite(s): CE-333L

Term Offered: Fall Term

Course Type(s): None

Biochemistry is a field about chemistry in living organisms. Biochemistry CE-333 is a 1-semester complete biochemistry course. This water-based chemistry will initially explore monomers (amino acids, monosaccharides and nucleotides) followed by their polymers (protein, polysaccharides and nucleic acids) with a focus on the relationship between their structure and function. Moreover, structures and properties of fatty acids to phospholipids and membranes will be studied. The properties of these molecules and how they all interact together will be further studies through the concepts of enzymology and metabolism. Being multidisciplinary, this course should be taken by chemistry majors, as well as students aiming at graduate school or medical professional fields. Prerequisite: CE-242 Corequisite: CE-333L

CE-333L Biochemistry Laboratory**Credits: 1**

Term Offered: Fall Term

Course Type(s): WT

CE-333L will provide training in modern biochemical techniques, using proteins, nucleic acids, carbohydrates and lipids. This laboratory will provide students with hands-on experience in basic and modern techniques commonly used in biochemistry, that will be required in the pursuit of their academic and career objectives. Prerequisites: EN-101 and EN-102 Corequisite: CE-333

CE-350 Research in Chemistry**Credits: 1-4**

Term Offered: All Terms

Course Type(s): EX5

Original research work, carried out under the mentorship of a faculty research advisor. Research conducted by the students may be submitted for presentation, publication, or review, as appropriate. The number of course credits will be determined by arrangement with the advisor. Three hours/week per credit, 1-3 credits. Prerequisites: Determined by faculty mentor.

CE-360 Biophysical Chemistry**Credits: 3**

Prerequisite(s): CE-242

Term Offered: All Terms

Course Type(s): None

Principles and applications of physical chemistry including thermodynamics, kinetics and spectroscopy to study the structure and function of biological macromolecules. Prerequisite: CE-242

CE-360L Biophysical Chemistry Laboratory**Credits: 1**

Prerequisite(s): CE-242

Term Offered: All Terms

Course Type(s): None

The Lab course is designed to give hands-on experience with contemporary experimental instrumentation and techniques that are widely used in the biophysical characterization of biological macromolecules. Students will also work on individual projects designed to provide a real-life academic/industrial research experience and will submit a clear and concise report and presentation based on the experimental results. Prerequisite: CE-242 Corequisite: CE-360

CE-374 Industrial Chemistry**Credits: 3**

Prerequisite(s): CE-242

Term Offered: Fall Term

Course Type(s): None

A treatment of some reaction chemistry, chemical processes, thermodynamics, chemical equilibria, and kinetics that are important to the chemical industry. Fundamental principles and problems of the chemical industry will also be discussed.

CE-381 Physical Chemistry I**Credits: 3**

Prerequisite(s): MA-116, PH-212, both passed with a grade of C- or higher.

Co-requisite(s): CE-381L.

Term Offered: Fall Term

Course Type(s): None

Basic principles of quantum mechanics essential for understanding of atomic and molecular spectroscopy are covered. The specific topics included: Quantum Mechanics: postulates and formulation of Schrodinger equation, uncertainty principle, particle in a box, simple harmonic oscillator, rigid rotor, Hydrogen atom, hydrogenic wave functions, Pauli principle, Helium atom, Hydrogen molecule, Molecular Orbital Theory; Introduction and applications of Computational Chemistry; Spectroscopy; Light-matter interaction, term symbols, spectroscopic selection rules, electronic spectra of atoms and molecules, rotational and vibrational spectra, IR and Raman spectroscopy, Lasers.

CE-381L Physical Chemistry I Laboratory**Credits: 1**

Prerequisite(s): EN-101 and EN-102 or permission of the instructor.

Co-requisite(s): CE-381.

Term Offered: Fall Term

Course Type(s): WT

This course is designed to be taken concurrently with CE-381, Physical Chemistry I. The experiments performed complement material studied in CE-381. Topics covered include: UV-Vis, FT-IR, Raman, Laser Induced Fluorescence, and Flash Photolysis spectroscopies. This laboratory also requires the use of modern computer platforms and quantum chemistry software for molecular simulations and data analysis.

CE-382 Physical Chemistry II**Credits: 3**

Prerequisite(s): MA-116, PH-212 and CE-381, all passed with a grade of C- or higher

Co-requisite(s): CE-382L

Term Offered: All Terms

Course Type(s): None

Amplification of concepts in thermodynamics, chemical kinetics and dynamics and application of these to gases, liquids, and solutions to provide a solid background for understanding the physical principles that govern behavior of chemical and biological systems. The specific topics included: Thermodynamics: standard functions (enthalpy, entropy, etc.), ensembles, partition function. Gibbs chemical potential, phase equilibria, electrochemical cells; Kinetic Theory of Gases: Maxwell-Boltzmann distribution, collision frequency; effusion rate, heat capacity, transport processes (diffusion, viscosity, etc.); Chemical Kinetics: differential and integral expressions for rate laws, reaction mechanisms, Chemical Dynamics: collision theory, absolute rate theory, transition state theory. Corequisite: CE-382L

CE-382L Physical Chemistry II Laboratory**Credits: 1**

Prerequisite(s): EN-101 and EN-102 or permission of the instructor.

Co-requisite(s): CE-382.

Term Offered: Spring Term

Course Type(s): WT

This course is designed to be taken concurrently with CE-382, Physical Chemistry I. The experiments performed complement material studied in CE-382. Topics covered include experimental investigation of gas laws, phase transitions, transport properties of gases (diffusion), electrochemistry (electrolysis, electroplating, and voltammetry) and chemical kinetics (fluorescence quenching). This laboratory also requires the use of modern computer platforms and quantum chemistry software for simulations of chemical kinetics, dynamics and data analysis.

CE-388 Cooperative Education: Chemistry**Credits: 1-3**

Prerequisite(s): CE-221, CE-221L, CE-242, and CE-242L; an overall G.P.A. of 2.00; fifteen credits completed at Monmouth University, and approval of the Department of Chemistry

Term Offered: Spring Term

Course Type(s): EX2

Application of chemical concepts and skills learned in lecture and laboratory to work-related experiences. Students and faculty sponsors maintain journals of their cooperative education opportunities with the assistance of the Director of Cooperative Education. Students will work forty hours per credit per semester at their jobs. Students will maintain journals of their cooperative education experiences and write reports demonstrating how their experiences helped them achieve their learning goals. This is a pass/fail course. Departmental approval is required to take this course.

CE-389 Internship in Chemistry**Credits: 1-3**

Prerequisite(s): CE-221, CE-221L, CE-242, CE-242L, an overall GPA of 2.00, fifteen credits completed at Monmouth University, and approval by the Department of Chemistry

Term Offered: All Terms

Course Type(s): EX1

Provides an opportunity to apply chemical concepts and skills learned in lecture and laboratory to work-related experiences. Students and faculty sponsors will identify internship opportunities. Students will work forty hours per credit per semester in their internship positions. Students will maintain journals of their internship experiences and write reports demonstrating how their internship experiences helped them achieve the learning objectives identified at the start of the internships. This is a pass/fail course.

CE-398 Special Topics in Chemistry (300 Level)**Credits: 1-3**

Prerequisite(s): CE-241, CE-241L, CE-242, CE-242L, or as announced in the course schedule

Term Offered: Spring Term

Course Type(s): None

An intensive study of a particular subject or problem in chemistry to be announced prior to registration. May be conducted in a lecture, seminar, or laboratory format.

CE-398L Special Topics in Chemistry**Credits: 3**

Course Type(s): None

An intensive study of a particular subject or problem in chemistry to be announced prior to registration. Conducted in a laboratory format.

CE-399 Independent Study in Chemistry (300 Level)**Credits: 1-3**

Term Offered: All Terms

Course Type(s): None

Original research work planned and carried out with the assistance of a faculty research advisor. The number of credits will be arranged with the advisor. Prior permission of the directing professor and department chair is required to take this course.

CE-401 Advanced Inorganic Chemistry**Credits: 3**

Prerequisite(s): CE-242 and CE-242L both passed with a grade of C- or higher

Term Offered: All Terms

Course Type(s): None

Modern theories of inorganic chemistry, including advanced considerations of atomic and molecular structure, chemical bonding, complex ions, solid state chemistry, magnetic properties of ions, periodicity, and contemporary problems.

CE-401L Advanced Inorganic Chemistry Laboratory**Credits: 1**

Co-requisite(s): CE-401

Term Offered: All Terms

Course Type(s): None

Inorganic synthetic techniques, including inert atmosphere, high temperature, and non-aqueous solvents; methods of characterization of inorganic compounds, including use of spectroscopic and other instrumental methods. Three hours per week.

CE-405 Methods of Inorganic Chemistry

Prerequisite(s): CE-401

Term Offered: Spring Term

Course Type(s): None

Coverage of important experimental methods in inorganic structural determinations. Topics include symmetry and group theory, computational methods, mass spectrometry, diffraction analysis and nuclear magnetic resonance, electron paramagnetic resonance, rotational, Mossbauer, vibrational, electronic absorption, photoelectron spectroscopies. The application of these techniques to the characterization and determination of inorganic substances is the emphasis of the course.

CE-432 Advanced Analytical Chemistry

Prerequisite(s): CE-322 passed with a grade of C- or higher.

Term Offered: All Terms

Course Type(s): None

This course examines modern analytical techniques with special emphasis on gas chromatography (GC), liquid chromatography (LC) and capillary electrophoresis (CE) in terms of basic principles, instrumentation, method development and practical applications. Mass spectrometry (MS) and ion mobility spectrometry (IMS) are also extensively explored as detection techniques for GC (GC-MS and GC-IMS), LC (LC-MS), and CE (CE-MS). Multidimensional separations (LC x LC & GC x GC) and their practical applications are also examined. A combination of traditional lecture notes, textbook readings and published peer-reviewed scientific literature will be used to explore and discuss topics. The course also involves case studies on analytical method development, data interpretation and applications of analytical techniques covered as well as visits to or tours of facilities with sophisticated analytical instrumentation relevant to the course.

CE-452 Advanced Organic Chemistry

Prerequisite(s): CE-242 and CE-242L both passed with a grade of C- or higher

Term Offered: Spring Term

Course Type(s): None

Selected topics of modern, theoretical, organic chemistry.

CE-454 Advanced Biochemistry

Prerequisite(s): CE-333

Term Offered: Spring Term

Course Type(s): None

Advanced Biochemistry provides a deeper focus on the biochemistry of several diseases as well as medical biochemistry while building upon the concepts learned in the prerequisite biochemistry course (CE-333). Using current publications to support content, topics such as gene therapy, various blood test works will be discussed. Topics of the biochemistry of Cancer, AIDS and Aging will also be covered.

CE-460 Electrochemical Methods

Co-requisite(s): CE-341

Term Offered: Spring Term

Course Type(s): None

Theory and applications of electrochemical analysis: electrode processes, thermodynamics and kinetics of electrode reactions, controlled potential and controlled current microelectrode techniques, and bulk electrolysis.

CE-475 Computational Chemistry and Molecular Modeling Credits: 3

Prerequisite(s): CE-341 and CE-341L both passed with a grade of C- or higher

Term Offered: Spring Term

Course Type(s): None

Principal methods and techniques used to study organic molecules and biomolecules by computational methods. Interpretation of chemical data with the aid of a computer. Atomic and molecular orbitals, force fields, molecular dynamics, and molecular modeling and drug design.

CE-484 Methods Development and Statistical Process Control Credits: 4

Prerequisite(s): CE-432 and MA-151 both passed with a grade of C- or higher.

Term Offered: All Terms

Course Type(s): None

Concentrates on methods development in the analytical laboratory with applications in pharmaceutical, food product, cosmetics, and environmental testing. This course focuses on methods development and optimization to satisfy regulatory and customer requirements, validating analytical methods, application of newer analytical methods, and those involved in quality control, quality assurance, and quality assessment. Discusses regulatory framework and requirements including FDA, WHO, and ICH examples. Focus includes development and use of statistical process control as tools to improve quality and productivity.

CE-486 Medicinal Chemistry

Prerequisite(s): CE-241 and CE-242

Term Offered: Spring Term

Course Type(s): None

A Medicinal Chemistry course in which you will learn about the application of chemistry to the discovery, design and synthesis of new drugs. Medicinal chemistry is an interdisciplinary science. Its successful application to new drug discovery and development involves knowledge of organic chemistry, biology, physiology, microbiology, biochemistry, pharmacology and medicine among others. Topics that will be covered in this course include: structure and function of biological targets (proteins, enzymes, receptors and DNA/RNA); sources of new drugs from nature or synthesis; methods used to identify relevant structural features for biological activity; fate of a drug in the body and interaction with its biological target (pharmacokinetics and pharmacodynamics); strategies for drug design and case studies.

CE-489 Internship in Chemistry Credits: 1-3

Prerequisite(s): CE-221, CE-221L, CE-242, CE-242L, an overall GPA of 2.00, fifteen credits completed at Monmouth University, and approval by the Department of Chemistry

Term Offered: Spring Term

Course Type(s): EX1

Provides an opportunity to apply chemical concepts and skills learned in lecture and laboratory to work-related experiences. Students and faculty sponsors will identify internship opportunities. Students will work forty hours per credit per semester in their internship positions. Students will maintain journals of their internship experiences and write reports demonstrating how their internship experiences helped them achieve the learning objectives identified at the start of the internships. This is a pass/fail course.

CE-498 Special Topics in Chemistry (400 Level) Credits: 1-3

Prerequisite(s): CE-242 or as announced in the course schedule

Term Offered: Spring Term

Course Type(s): None

An intensive study of a particular subject or problem in chemistry to be announced prior to registration. May be conducted in a lecture, seminar, or laboratory format.

CE-499 Independent Study in Chemistry**Credits: 1-3**

Term Offered: All Terms

Course Type(s): None

Original research work planned and carried out with the assistance of a faculty research advisor. The number of course credits will be arranged with the advisor. Three hours per credit. Prior permission of the directing professor and department chair is required to take this course.

CE-499T Independent Study in Chemistry**Credits: 3**

Term Offered: All Terms

Course Type(s): None

Original research work planned and carried out with the assistance of a faculty research advisor. Prior permission of the directing professor and department chair is required to take this course.

ML-411 Clinical Internship in Medical Laboratory Science I**Credits: 16**

Term Offered: All Terms

Course Type(s): EX1, WT

First half of an intensive one-year clinical internship and training at an approved, partner medical institution in the requisite skills for a career in medical laboratory science. Practical experience in tests and procedures of hematology, histology, blood bank, clinical microscopy, clinical chemistry, bacteriology, parasitology, mycology, immunology, serology, radioisotopes, and related subjects. Limited to Medical Laboratory Science majors who have completed all other degree requirements.

ML-412 Clinical Internship in Medical Laboratory Science II**Credits: 16**

Prerequisite(s): ML-411

Term Offered: Spring Term

Course Type(s): EX1

Second half of an intensive one-year clinical internship and training at an approved, partner medical institution in the requisite skills for a career in medical laboratory science. Practical experience in tests and procedures of hematology, histology, blood bank, clinical microscopy, clinical chemistry, bacteriology, parasitology, mycology, immunology, serology, radioisotopes, and related subjects. Limited to Medical Laboratory Science majors who have completed all other requirements.

MM-490 Experience in Clinical Medicine**Credits: 9**

Term Offered: All Terms

Course Type(s): EX5

Intensive, practical, first-hand experience in clinical medicine at Monmouth Medical Center. A comprehensive introduction to the skills required to practice medicine: excellent communication, critical reading of the literature, epidemiologic methods (disease patterns in populations), and understanding medicine as a human experience. The practicum consists of clinical observations, seminars, community service, discussion groups, and a research paper. This course is under the auspices of the Biology Department. Limited to Monmouth Medical Center Scholars with Junior standing. This is a pass/fail course.

PH-101 Physics in Our Lives**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

Presents major concepts and methodologies in physics and their importance in today's society. Introduction to principles of physics and their applications to today's technology using lectures and demonstration.

PH-103 The Physics of Sound and Music**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

Presents the topics of sound and music from a physics point of view. Covered topics are harmonic motion, waves (both traveling and standing), the human voice and ear, the production of music and musical scales and the physics of several representative instruments.

PH-105 Physics for the Life Sciences I**Credits: 3**

Prerequisite(s): MA-101 or MA-109 or MA-115 or higher Math courses passed with grade of C- or higher.

Co-requisite(s): PH-105L

Term Offered: All Terms

Course Type(s): NS

An introduction to classical physics intended primarily for students majoring in the life sciences. Topics include: mechanics, dynamics, heat, electricity, magnetism, and optics.

PH-105L Physics for the Life Sciences I Laboratory**Credits: 1**

Co-requisite(s): PH-105

Term Offered: All Terms

Course Type(s): None

Laboratory work to complement PH-105. Experiments in the fields of statics, dynamics, energy, momentum, heat, sound, electricity, magnetism, optics, and spectroscopy. Three hours per week.

PH-106 Physics for the Life Sciences II**Credits: 3**

Prerequisite(s): PH-105 and PH-105L both passed with a grade of C- or higher

Co-requisite(s): PH-106L

Course Type(s): NS

An introduction to classical physics intended primarily for students majoring in the life sciences. Topics include, mechanics, dynamics, heat, electricity, magnetism, and optics.

PH-106L Physics for the Life Sciences II Laboratory**Credits: 1**

Co-requisite(s): PH-106

Course Type(s): None

Laboratory work to complement PH-106. Experiments in the fields of sound, electricity, magnetism, optics, and spectroscopy. Three hours per week.

PH-150 Principles of Astronomy**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

The historical development of astronomy and the modern concepts of the universe, including demonstrations and viewing sessions with optical telescopes.

PH-199 Independent Study in Physics**Credits: 1**

Term Offered: All Terms

Course Type(s): None

Guided study of a selected topic in physics not substantially treated in a regular course, under the direction of a member of the Physics faculty. Prior permission of the directing professor and department chair is required to take this course.

PH-211 General Physics with Calculus I**Credits: 3**

Prerequisite(s): MA-116 or MA-125

Co-requisite(s): PH-211L

Term Offered: Fall Term

Course Type(s): NS

The first of a two-semester sequence of courses that, taken together, provide a thorough introduction to classical physics using calculus.

Topics covered include: one- and two-dimensional motion, Newton's laws and their applications, energy, momentum and impulse, rotational mechanics, and thermodynamics.

PH-211L General Physics with Calculus I Laboratory**Credits: 1**

Co-requisite(s): PH-211

Term Offered: Fall Term

Course Type(s): None

Laboratory experiments to complement the topics covered in PH-211.

Includes experiments in statics, dynamics, and thermodynamics.

PH-212 General Physics with Calculus II**Credits: 3**

Prerequisite(s): PH-211 and PH-211L passed with a grade of C- or higher.

Co-requisite(s): PH-212L

Term Offered: Spring Term

Course Type(s): NS

The second of a two-semester sequence of courses that, taken together, provide a thorough introduction to classical physics using calculus.

Topics covered include: sound and wave mechanics, electrostatics, circuits, magnetic forces and fields, Faraday's Law, reflection and refraction, and optics.

PH-212L General Physics with Calculus II Laboratory**Credits: 1**

Co-requisite(s): PH-212

Term Offered: Spring Term

Course Type(s): None

Laboratory experiments to complement the topics covered in PH-212.

Includes experiments in sound, electricity, magnetism, circuits, and optics.

PH-270 Physical Oceanography**Credits: 3**

Prerequisite(s): BY-109, CE-111, CE-111L, CE-112, and CE-112L

Term Offered: Fall Term

Course Type(s): MEBP

Physical Oceanography provides a survey of physical, chemical and geological processes that define and affect the coastal ocean including ocean basins, beach formation and dynamic ocean processes (currents, waves, wind, weather). Environmental considerations include the role of the ocean in the association with global climate change issues, problems associated with coastal development, exploitation of marine resources, and ocean and coastal pollution.

PH-298 Special Topics in Physics (200 Level)**Credits: 1-3**

Term Offered: Spring Term

Course Type(s): None

An intensive study of a particular subject or problem in physics to be announced prior to registration. May be conducted on either a lecture-discussion or a seminar basis. If a prerequisite is required it will be announced in the course schedule.

PH-299 Independent Study in Physics**Credits: 1-3**

Term Offered: All Terms

Course Type(s): None

Guided study of a selected topic in physics not substantially treated in a regular course, under the direction of a member of the Physics faculty. Prior permission of the directing professor and department chair is required to take this course.

PH-311 Theoretical Physics**Credits: 3**

Prerequisite(s): PH-212 passed with a grade of C- or higher

Term Offered: All Terms

Course Type(s): None

Presents physics topics aimed at the advanced undergraduate level.

The subjects range over classical mechanics, electromagnetism, and statistical mechanics, with explicit links made to topics from PH-301. The course is calculus-based, and seeks to round out the physics education of physics minors.

PH-312 Modern Physics**Credits: 3**

Prerequisite(s): PH-311 passed with a grade of C- or higher

Term Offered: Spring Term

Course Type(s): None

Topics from physics of the twentieth century, including special relativity, the origins of quantum theory, quantum mechanics, atomic structure, nuclear physics, and elementary particles.

PH-350 Research in Physics**Credits: 1-3**

Term Offered: All Terms

Course Type(s): EX5

Original research work, carried out under the mentorship of a faculty research advisor. Research conducted by the students may be submitted for presentation, publication, or review, as appropriate. The number of course credits will be determined by arrangement with the advisor. Three hours/week per credit, 1-3 credits.

PH-399 Independent Study in Physics**Credits: 1-3**

Term Offered: Spring Term

Course Type(s): None

Reading and research on a selected topic under the direction of a Physics faculty member. Prior permission of the directing professor and department chair is required to take this course.

PH-499 Independent Study in Physics (400 Level)**Credits: 1-3**

Course Type(s): None

Reading and research on a selected topic under the direction of a Physics faculty member. Three hours per week per credit. Prior permission of the directing professor and department chair is required to take this course.

SC-100 Discovery and Thinking in Natural Sciences**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

The development of major concepts in the biological, chemical, and physical sciences; their importance today.

SC-103 Physical Geography**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

A survey of the Earth sciences from a spatial perspective. We will use maps, diagrams, simulations, and computer mapping software to learn about the systems of the Earth. Students will gain an understanding of physical processes and patterns of the Earth's atmosphere, climate, landforms, and biosphere. Understanding of these systems will be used to examine the ways in which humans influence and adapt to Earth systems. The learning outcomes of this course satisfy a general education requirement for the Natural Sciences. Also listed as GO-103.

SC-110 Nutrition Science

Term Offered: All Terms

Course Type(s): NS

An overview of the science of human nutrition, including the basics of protein, carbohydrate, lipid, vitamin, mineral, water, and alcohol metabolism. An analysis of the relationship of diet to various health issues and current controversies in nutrition will be covered. Students will learn the elements of nutritional analysis by evaluating their personal diets. Emphasis will be on the manner in which nutrition knowledge is acquired, including a nutrition study conducted by the students.

Credits: 3 SC-160 Science of Energy**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

Energy consumption is a key aspect of society that has been profoundly impacted by abundant low-cost energy. What does the future of energy look like in terms of abundance and cost? This course examines energy sources, energy needs, and the transition from geologically stored energy sources (fossil fuels) to ecologically available energy sources and conservation. It also explores the potential environmental consequences of such transition in the immediate future and long-term.

SC-120 The Science of Food and Cooking**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

This course covers concepts from chemistry, biology and physics that underpin the principles of food science and the transformations that occur during food preparation and cooking. Students will develop a scientific understanding of food preparation, cooking techniques, and recipes. Cooking demonstrations and experiments will be used to illustrate the scientific concept involved. Note: This course involves the preparation and (optional) consumption of food. If you have specific food allergies or needs, contact the instructor to discuss any necessary arrangements.

SC-170 Oceanography**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

Oceanography provides a survey of physical, biological, chemical, and geological resources and the processes that define and affect ocean basins, coasts, beaches, estuaries, offshore waters and marine species. Environmental considerations include the role of oceans in global climate change issues, coastal development, exploitation of marine resources, and marine pollution. Students in the Marine and Environmental Biology and Policy (MEBP) program should take PH-270, Physical Oceanography, for elective credit.

SC-130 Climate Science for 21st Century Citizens**Credits: 3**

Term Offered: All Terms

Course Type(s): SUS, NS

Earth's climate has changed in the past and will change in the future. Climate science and hypotheses about climate change and man's effects on climate figure prominently in the news and popular culture. However, forces and feedbacks impacting climate are poorly understood by the general public. This lack of understanding originates partially because climate science is complicated and interdisciplinary, and partially because addressing climate change requires significant changes in the global energy economy, turning it into a political issue with skewed and un-scientific public discourse. This course aims to cover parts of climate science that are well established, differentiate them clearly from parts of climate science where genuine uncertainty exists and use these contrasts to illustrate the scientific methods, culture of science and science practices of the 21st Century.

SC-198 Special Topics in Science**Credits: 3**

Term Offered: Spring Term

Course Type(s): NS

Study of a particular subject or problem in science to be announced prior to registration. May be conducted on either a lecture-discussion or seminar basis. Courses would meet General Education requirements in the natural sciences. If a prerequisite is required it will be announced in the course schedule.

SC-140 Forensic Science**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

An introductory course in which scientific principles will be applied to the methods used to investigate and solve crimes. The course will focus on the principles and methods utilized in the traditional sciences of biology, chemistry, and physics. The scientific techniques used to collect and analyze evidence will be covered.

SC-233 Climate Science: Understanding our Changing Climate Credits: 3

Prerequisite(s): BY-109 or permission of the instructor

Course Type(s): NS, SUS

Climate Change is arguably the most important problem of the 21st century. Climate Science Understanding Our Changing Climate provides students with a quantitatively rigorous treatment of basic climate science as well as a scientific exploration of impacts caused by human-mediated climate change. This course aims to cover climate science from an explicitly interdisciplinary perspective, because climate science depends on chemistry, physics, biology, mathematics, computer modeling and geology for complete understanding of the climate system and because workable climate solutions are almost always interdisciplinary in nature. Climate modeling and assessment of future climate conditions and risks will be stressed.

SC-150 Drug Discovery**Credits: 3**

Term Offered: All Terms

Course Type(s): NS

Concepts of biology, chemistry and pharmacology are used to examine aspects of drug discovery from early recorded history to modern treatments for disease. Additionally, students will understand the impacts of key drug discoveries on society/public health. Note: No prior biology/chemistry knowledge is assumed.