

# DEPARTMENT OF CHEMICAL AND ENVIRONMENTAL SCIENCES

*Mission: The Chemistry Department seeks to provide the training and Christian environment to prepare students for careers in elementary and secondary education, to provide the background in chemistry necessary for other areas of study such as biology and to prepare students for professional programs in such areas as dentistry, pharmacy, optometry, medicine, veterinary medicine, nursing, and physical therapy, and to prepare students for graduate studies in chemistry.*

The Chemistry Department houses both chemistry and physics disciplines as a part of the College and serves not only chemistry but also other allied disciplines within the undergraduate program. There are three degrees available within the Chemistry Department: a Bachelor of Science (B.S.) in Chemistry, a Bachelor of Science (B.S.) in Biochemistry and a Bachelor of Science (B.S.) in Environmental Sciences. All majors in Natural and Physical Sciences are expected to make satisfactory academic progress toward graduation. In addition to the requirements established by the University, students must maintain a 2.0 in all major coursework. Further, the Department also requires a minimum grade of C- as completion for pre-requisites in science-related coursework for all students enrolled in MATH, BIOL, ENVR, CHEM, and PSCI courses, regardless of major.

The B.S. program provides undergraduate preparation for technical employment or post-baccalaureate study in graduate school or for professions such as medicine, and other health professions and natural resource management. A Chemistry major considering graduate or professional school should confer with a Chemistry advisor to plan a program to meet the student's needs and assure entrance into such a school. An Environmental Sciences major considering graduate or engineering school should also confer with a faculty advisor to plan a program to meet the student's needs and assure entrance into such a school.

## VISTA: Chemistry Education Minor Courses

The Vanguard Integrated STEM Teacher Achievement Program (VISTA) is one of several Integrated Teaching Education Programs (ITEP) offered at Vanguard. The ITEP program allows for students to complete not only their bachelor's degree but also the California Teaching Credential within four years. This is a great option for students preparing to teach chemistry at the secondary school level. The Bachelor of Science in Chemistry or Biochemistry degree with this option is pending approval by the California Commission on Teacher Credentialing. Completion of this option will satisfy the subject matter requirement for the Single Subject Teaching Credential in Chemistry within 4 years. Students wishing to graduate on a four-year plan are still eligible to enroll in the fifth year credential program at Vanguard University or some other accredited college or university to complete subject requirements for the California Clear Teaching Credential in Chemistry (see the Graduate Program in Education for these requirements). Students completing this option must take CHEM-120 General Chemistry I, CHEM-121

General Chemistry II, CHEM-304 Organic Chemistry I, CHEM-430 Biochemistry, and PSCI-225 Electricity and Magnetism. They should also take EDUC-315 Teaching in a Multicultural Setting, ENGL-453 Language, Culture, and Linguistics and POLS-155C American Democracy (see requirements tab).

Students must fulfill the core requirements and the requirements for one of the four specific degrees offered.

## Program Learning Outcomes Student Learning Outcomes

VUSC Chemistry graduates should have:

1. Demonstrated an understanding of the major concepts, theories, and experimental evidence of and the ability to solve problems in: Analytical Chemistry, Biological Chemistry, General Chemistry, Organic Chemistry, and Physical Chemistry.
2. Demonstrated competence in practical laboratory-based aspects of chemistry, including: basic laboratory skills, selection and use of modern instruments, proper standardization and calibration practices, and computer-based data acquisition.
3. Developed critical thinking skills and problem-solving approaches using scientific methods to: identify the relevant factors which define problems, develop and evaluate methods, employ appropriate statistical analysis and instrumentation, and draw reasonable conclusions.
4. Identified the principles in the American Chemical Society Ethics Code, recognized ethical components in complex situations, designed solutions appropriate to professional standards, and practiced science in a safe manner.
5. Demonstrated comprehension of chemical literature and the ability to communicate professionally about chemistry through writing in an accepted scientific format and orally in a public venue.
6. Acquired familiarity with the process of chemical research through the formal participation in an undergraduate research project that involved: project management, methods development, data analysis, and written contribution to the discipline in the form of a presentation or publication.

Students must fulfill the core requirements and the requirements for one of the three specific degrees offered.

## Programs Majors:

- Biochemistry B.S. (<https://catalog.vanguard.edu/stem/undergraduate/chemical-environmental-sciences/biochemistry-bs/>)
- Chemistry B.S. (<https://catalog.vanguard.edu/stem/undergraduate/chemical-environmental-sciences/chemistry-bs/>)
- Chemistry B.S. with an Education Minor (VISTA) (<https://catalog.vanguard.edu/stem/undergraduate/chemical-environmental-sciences/chemistry-bs-education-minor/>)
- Environmental Sciences (B.S.) (<https://catalog.vanguard.edu/stem/undergraduate/chemical-environmental-sciences/environmental-science-bs/>)



## Minors:

- Chemistry Minor (<https://catalog.vanguard.edu/stem/undergraduate/chemical-environmental-sciences/chemistry-minor/>)

## Courses Chemistry

### CHEM-112C Fundamentals of General, Organic, and Biochemistry I 3 Credits

An introduction to the study of matter and properties. The course surveys in one semester chemical topics such as: atomic theory, periodic trends, measurements and stoichiometry, chemical reactions, reduction and oxidation chemistry, chemical equilibrium, nuclear chemistry acids and bases. This course is designed for students who need a refresher in general chemistry. It also serves as an excellent introductory course for students in the health sciences or as a general science for non-majors. Course fulfills Core education laboratory science requirement. Lecture three hours.

Co-Requisite: Concurrent: CHEM-112CL

### CHEM-112CL Fundamentals of General, Organic, and Biochemistry I Lab 1 Credit

A complementary laboratory course to CHEM-112C emphasizing the study of matter and properties. This hands-on course teaches basic techniques used in the chemistry lab. Sample experiments include: separation of compounds, chemical precipitation reactions, oxidation-reduction reactions, household chemical qualitative analysis. Laboratory three hours. Lab fee.

Co-Requisite: Concurrent: CHEM-112C

### CHEM-113 Fundamentals of General, Organic, and Biochemistry I 3 Credits

A continuation of the study of matter and its properties. This course explores the following areas of chemistry: Organic Chemistry and Biochemistry. Topics such as: organic functional groups, basic organic reactions, biomolecular structure, metabolism, protein synthesis, and instrumentation will be covered. This course is designed for students in the health sciences, liberal studies, or as a general science for non-majors. Lecture three hours.

### CHEM-113L Fundamentals of General, Organic, and Biochemistry II Lab 1 Credit

A complementary laboratory course for CHEM 113. This course implements the following experiments: organic synthesis of aspirin or other analgesics, synthesis of esters, separation of compounds using chromatographic techniques, synthesis of organic dyes, combustion of carbohydrates, analysis of proteins and DNA. This course is designed for students in the health sciences, liberal studies, or as a general science for non-majors. Laboratory three hours. Lab fee.

### CHEM-120 General Chemistry I 3 Credits

Fundamental concepts including chemical reactions, stoichiometry, atomic structure, chemical bonding, changes in state, and the periodic table. Should students not be prepared to succeed in chemistry, it is recommended that students enroll in CHEM-112C and CHEM-112CL. After successful completion of CHEM-112C and CHEM-112CL, the student can re-enter. Three hours lecture per week.

Co-Requisite: CHEM-120L

Pre- or Co-Requisite: CHEM-112C, CHEM-210C or passing score on the Chemistry Placement Exam.

### CHEM-120L General Chemistry I Lab 1 Credit

Students will learn introductory laboratory techniques such as observation, measurement, separations, and identification of reactions. Experiments will involve concepts including: atomic structure, chemical bonding, changes in state, periodic table, oxidation, kinetics, equilibrium, thermodynamics, and electrochemistry. One 4-hour laboratory session per week. Lab fee.

Prerequisite: CHEM-112CL or CHEM-210CL

Co-Requisite: CHEM-120

### CHEM-121 General Chemistry II 3 Credits

Fundamental concepts including kinetics, equilibrium, thermodynamics, and electrochemistry. Special topics will include nuclear chemistry, transition metal periodicity and coordination compounds. Three hours lecture per week.

Prerequisite: CHEM-120

Co-Requisite: CHEM-121L

### CHEM-121L General Chemistry II Lab 1 Credit

Students will continue their introduction to laboratory techniques including gravimetric and volumetric analysis, neutralization, and catalysis. Experiments will involve the concepts including: atomic structure, chemical bonding, changes in state, periodic table, oxidation, kinetics, equilibrium, thermodynamics, and electrochemistry. One 4-hour laboratory session per week. Lab fee.

Prerequisite: CHEM-120L

Co-Requisite: CHEM-121

### CHEM-210 Integrated Chemistry 4 Credits

This course is designed to give beginning students who have not had prior exposure to chemistry a basic overview in general, organic, and biochemistry. The following topics will be surveyed: matter and energy, atomic theory, stoichiometry, nomenclature, the periodic table, atomic structure, gas liquid and solid states, solutions, nuclear chemistry, functional groups, alkanes, alkenes, alcohols, ethers, aldehydes, ketones, amines, carboxylic acids, lipids, carbohydrates, amino acids, proteins, nucleic acids, metabolism and respiration, photosynthesis, transcription, translation, kinetics, and DNA replication. Upon completion of this integrated chemistry course, the student will have an understanding of basic principles paramount to the study of chemistry, a proficiency with stoichiometry (as it relates to the nursing discipline), writing and interpreting chemical formulas, DNA replication, transcription and translation. In addition, the student should develop an appreciation for the importance of chemistry in other disciplines. (Meets Chemistry requirement for RN to BSN students; meets Science/Lab requirement for Professional Studies students).



**CHEM-210C Integrated Chemistry 4 Credits**

This course is designed to give beginning students who have not had prior exposure to chemistry a basic overview in general, organic, and biochemistry. The following topics will be surveyed: matter and energy, atomic theory, stoichiometry, nomenclature, the periodic table, atomic structure, gas liquid and solid states, solutions, nuclear chemistry, functional groups, alkanes, alkenes, alcohols, ethers, aldehydes, ketones, amines, carboxylic acids, lipids, carbohydrates, amino acids, proteins, nucleic acids, metabolism and respiration, photosynthesis, transcription, translation, kinetics, and DNA replication. Upon completion of this integrated chemistry course, the student will have an understanding of basic principles paramount to the study of chemistry, a proficiency with stoichiometry (as it relates to the nursing discipline), writing and interpreting chemical formulas, DNA replication, transcription and translation. In addition, the student should develop an appreciation for the importance of chemistry in other disciplines. Meets the CORE Science Requirement for the traditional undergraduate student when taken with CHEM-201CL.

Co-Requisite: CHEM-210CL

Terms Typically Offered: Fall and Spring.

**CHEM-210CL Integrated Chemistry Laboratory 1 Credit**

A complementary laboratory course to CHEM-210C emphasizing the study of matter and properties. This hands-on course teaches basic techniques used in the chemistry lab. Sample experiments include: separation of compounds, chemical precipitation reactions, oxidation-reduction reactions, household chemical qualitative analysis. Further, the organic synthesis of aspirin or other analgesics, synthesis of esters, separation of compounds using chromatographic techniques, synthesis of organic dyes, combustion of carbohydrates, analysis of proteins and DNA are performed. This course is designed for students in the health sciences, liberal studies or as a general science for non-majors. This course fulfills the LAB CORE science requirement. Laboratory three hours. Lab fee.

Co-Requisite: CHEM-210

Terms Typically Offered: Spring.

**CHEM-212 Teaching Chemistry I 2 Credits**

This course will cover the design of chemistry laboratory experiments to demonstrate and foster the understanding of important chemical principles. Students will both design experiments and analyze experiments from a standard experimental text to determine which principles the experiment is designed to demonstrate. Particular attention will be paid to issues of safety both in the execution of an experiment and in the determination of its suitability for student involvement. In addition to three hours of lab per week, three mandatory visitations to a 6th-12th grade chemistry class per semester (at a public school) will be required. The students will provide oral and written reports on their experiences in the field visitations. Two semester sequence. Lab fee.

**CHEM-214 Teaching Chemistry II 2 Credits**

This course will cover the design of chemistry laboratory experiments to demonstrate and foster the understanding of important chemical principles. Students will both design experiments and analyze experiments from a standard experimental text to determine which principles the experiment is designed to demonstrate. Particular attention will be paid to issues of safety both in the execution of an experiment and in the determination of its suitability for student involvement. In addition to three hours of lab per week, three mandatory visitations to a 6th-12th grade chemistry class per semester (at a public school) will be required. The students will provide oral and written reports on their experiences in the field visitations. Two semester sequence. Lab fee.

**CHEM-252 Analytical Chemistry 3 Credits**

The theory of and techniques for calculations pertaining to classical gravimetric and volumetric methods, theory and techniques of separation, and an introduction to instrumental methods. Three hours lecture per week. Offered in alternate years.

**CHEM-252L Analytical Chem Techniques 1 Credit**

Laboratory experiments in classical gravimetric and volumetric methods, techniques of separation, and an introduction to instrumental methods. One four-hour laboratory session per week. Lab fee. Offered in alternate years.

**CHEM-304 Organic Chemistry I 3 Credits**

This course is designed to introduce students to organic chemistry. The following topics will be covered: bonding and atomic theory, nomenclature, stereochemistry, functional groups, substitution reactions, elimination reactions, and both electrophilic addition and aromatic substitution reactions. Students will develop a mastery of organic functional groups and nomenclature, an understanding of basic organic reaction mechanisms, a familiarity with common organic reactions, and an appreciation for the importance of organic chemistry in other disciplines. The student will be prepared to continue their education in organic chemistry in the sequential course (CHEM-305). Three hours of lecture per week.

Prerequisite: CHEM-121

Co-Requisite: CHEM-304L

**CHEM-304L Organic Chemistry Techniques I 1 Credit**

This is the complementary laboratory course for CHEM-304. This course is designed to develop basic skills and techniques for practical application of the general principles of organic chemistry. The development of a safe approach to lab experimentation will be stressed. Four-hour laboratory session per week. Lab fee.

Prerequisite: CHEM-121L

Co-Requisite: CHEM-304

**CHEM-305 Organic Chemistry II 3 Credits**

This course is designed as a continuation of the study of organic chemistry. Students will be introduced to various topics in organic chemistry including: organic oxidations and reductions, carbonyl chemistry, amines, carboxylic acids and their derivatives, organic mechanisms and various biological molecules and building blocks. Three hours of lecture per week.

Prerequisite: CHEM-304 and CHEM-304L

Co-Requisite: CHEM-305L



**CHEM-305L Organic Chemistry Technqs II 1 Credit**

This is the complementary laboratory course for CHEM-305. This course is designed to develop basic skills and techniques for practical application of the general principles of organic chemistry including identification of unknowns and multi-step synthesis. The development of a safe approach to lab experimentation will be stressed. Four-hour laboratory session per week. Lab fee.

Prerequisite: CHEM-304 and CHEM-304L

Co-Requisite: CHEM-305

**CHEM-309 Literature and Spectroscopy 2 Credits**

This course is designed for transfer students who have previously taken Organic Chemistry 1 and 2 at other institutions. This course introduces basic spectroscopic techniques of organic chemistry and biochemistry: IR, 1D and 2D NMR spectrometry, and MS with some discussion of UV/visible spectrophotometry. Collection and multi-spectral identification of organic compounds is emphasized. Additionally this course includes a survey of chemical literature and methods of its use with emphasis on locating specific chemical information in primary and secondary literature. One hour of lecture and two hours of lab per week. Lab Fee.

**CHEM-325 History & Philosophy of Science 3 Credits**

Study of selected topics in the history and philosophy of science and the application of these principles in analyzing contemporary scientific trends. Especially recommended for liberal studies majors and those planning to teach physical or biological sciences in secondary schools. Three hours of lecture per week.

**CHEM-430 Biochemistry 3 Credits**

This course covers topics at the interface of chemistry and biology with a focus on problems where chemistry has made a particularly strong contribution to the understanding of biological system mechanisms. The chemical reactions important to biology - and the enzymes that catalyze these reactions - are discussed in an integrated format. Topics include: the chemistry and biosynthesis of carbohydrates, proteins and nucleic acids; protein folding; enzyme catalysis; bioenergetics; key reactions of synthesis and catabolism; and chemical aspects of signal transduction. An appreciation for the increasing importance of biochemistry in the chemical sciences will be cultivated. Three hours of lecture per week. Offered in alternate years.

Prerequisite: CHEM-305 and CHEM-305L

Co-Requisite: CHEM-430L

**CHEM-430L Experimental Tech/Biochemistry 1 Credit**

This is the complementary laboratory course for CHEM-430. This course is designed to enhance the basic skills and techniques learned in the previous foundational experimental chemistry courses. This course focuses on modern biochemical techniques including the operation of chromatographic and spectroscopic instruments used in the practical application biological chemistry. The development of a safe approach to lab experimentation will be stressed. Four-hour laboratory session per week. Lab fee. Offered in alternate years.

Prerequisite: CHEM-305 and CHEM-305L

Co-Requisite: CHEM-430

**CHEM-435 Advanced Biochemistry 3 Credits**

Advanced Biochemistry provides an in depth view of biosynthesis, the biochemistry of muscle action, hormones and their function, active transport, organ interrelationship in metabolism, oncology, the structure of genetic material and replication and expression of DNA. Other topics of interest may be covered. Three hours of lecture per week. Offered in alternate years. Two hours of lecture plus an additional ~6 hours of online assignments per week.

**CHEM-440 Instrumental Analysis 2 Credits**

An introduction to modern instrumental chemical analysis. The course will span theory of operation, instrument design and methodology, and applications of instrumental techniques. Electrochemical methods including potentiometry, voltammetry, and coulometry; spectroscopic methods including infrared, UV-Vis, and NMR; chromatographic methods including gas, liquid and thin layer; and thermal methods of analysis and kinetic methods of analysis will be covered.

Prerequisite: CHEM-252

**CHEM-440L Instrumental Analysis Lab 2 Credits**

Prerequisite: CHEM-252L

Co-Requisite: CHEM-440

**CHEM-450 UG Research Or Internship Program 1-4 Credits**

Prerequisite: Open to juniors and seniors. This course may be taken for a maximum of 4 units in one semester. A maximum of 6 combined units credit for CHEM-450 or CHEM-485 apply to graduation. This course is designed with the purpose of providing students the opportunity to conduct research off-campus at universities or STEM companies in the community. This course promotes early entry into the workplace for the student through part-time employment. This course requires actual work experience be sought in a biotech or STEM-focused business firm providing an opportunity to integrate classroom teaching in practical application under the direct supervision of the assigned instructor. Students are responsible for completing a project report and presenting their research results in CHEM-499C.

Prerequisite: CHEM-121

Terms Typically Offered: Summer.

**CHEM-455 Chemistry Teaching Internship 1-3 Credits**

Regular hours each week for classes and/or meetings are established at the beginning of the semester. The intern assists an instructor in planning and conducting a course, and/or laboratory sessions. This course may be taken for 1-3 units per semester. May be repeated for a maximum of six units.

**CHEM-456 Physical Chemistry: Thermodynamics 2 Credits**

Laws, principles and concepts of chemistry concerning the properties of gases, the laws of thermodynamics, the theory and equations of phase changes in both pure and mixed substances, chemical equilibrium, equilibrium electrochemistry. Two hours lecture per week. Offered in alternate years.

Prerequisite: CHEM-121, MATH-181; MATH-281 preferred.

**CHEM-456L Physical Chemistry Technique Lab 1-2 Credits****CHEM-457 Physical Chemistry: Kinetics 2 Credits**

Laws, principles and concepts of chemistry concerning molecular motion and diffusion, both classical and molecular chemical kinetics, and introductory statistical mechanics. Two hours lecture per week. Offered in alternate years.



**CHEM-458 Physical Chemistry: Quantum Mechanics 2 Credits**

Laws, principles, and concepts of chemistry concerning: quantum mechanics; quantum properties of atoms and molecules; symmetry of molecules; rotational, vibrational, electronic, and magnetic (nuclear) spectroscopy and introductory statistical mechanics. Two hours lecture per week. Offered in alternate years.

**CHEM-470 Special Topic: 1-4 Credits**

Study in a special topic in chemistry. May be repeated for credit. May have a lab fee. Topics may include advanced inorganic chemistry, rates and mechanisms in organic chemistry, synthetic methods in organic chemistry, or other advanced topics.

**CHEM-480 Individual Studies: 1-4 Credits****CHEM-485 Undergraduate Research 1-4 Credits**

Problems in advanced laboratory research with emphasis on research techniques. Research is carried out under the supervision of the instructor with weekly conferences to discuss results and direction. Emphasis will be placed on project management, safety, instrumentation, solution preparation, and research documentation skills. A written proposal and report emphasizing the literature background of the problem and the experimental results are required. The results of the research project will also be presented in an oral format in CHEM-499C. This course is a variable credit course. At least two units are required for all chemistry and biochemistry majors. A minimum of 50 hours of laboratory work is required per unit. May be repeated. Lab fee.

**CHEM-499C Chemistry Capstone Seminar 2 Credits**

This course includes a senior thesis covering an approved research topic, analysis and evaluation of current research in chemistry, and the integration of faith and the chemical sciences. An oral presentation of the senior thesis in a classroom setting is required. In-class presentations by faculty and guests are part of the course. Laboratory research in an on-campus research program or an approved off-campus research program may be required for the senior thesis. This course fulfills the Core Curriculum Capstone requirement for Chemistry majors.

## Environmental Sciences

**ENVR-150C Intro to Environmental Science 3 Credits**

An introductory course focusing on the scientific analysis of environmental issues. Using core concepts from physics, chemistry, biology and earth science, students will examine key issues associated with sustaining biodiversity, natural resources, environmental health, and human societies. Topics will include ecological principles; land, water and energy use; epidemiology and toxicology; air, water and solid waste pollution; ecological economics; and environmental policy, law and planning. This course fulfills the University Lab Science CORE requirement. The course has a corresponding laboratory course. Co-Requisite: ENVR-150CL

**ENVR-150CL Intro to Environmental Science Lab 1 Credit**

An introductory complementary lab course focusing on the methods of collection and analysis of environmental samples. The Environmental Science laboratory focuses on environmental issues such as climate variation, atmospheric pollution and non-point-source water pollution. The course is made up of laboratory exercises with up to two field labs. In this course, students learn to investigate the natural world through the process of the "scientific method." Lab exercises provide an opportunity to make scientific observations, ask questions, develop explanations, design experiments and gather data. The lab exercises are designed to provide a basic understanding of how scientists investigate the world and the terminology that is used. Students have the opportunity to put the lab experience into real world scientific investigation. The course culminates in a field research project. Laboratory Course for 3 hours and lab fees. Co-Requisite: ENVR-150C

**ENVR-205C Introduction to Geology 3 Credits**

An introductory course focusing on the study of the kind and arrangement of materials composing the earth's crust and the geological processes at work on and within the earth's surface. This course covers the fundamentals of geology: Rocks, minerals, geologic time, plate tectonics, earthquakes, volcanoes, surface processes, and earth resources. This course fulfills the University Lab Science CORE requirement. The course has a corresponding laboratory course.

**ENVR-205CL Introduction to Geology Laboratory 1 Credit**

Corresponding laboratory for identification of rocks and minerals. Introduction to topographic maps and how they are used to interpret geologic processes and geologic history. Interpretation of geologic maps and data relating to earthquakes and plate tectonics. Course will consist of local field excursions and laboratory exercises. Pre- or Co-Requisite: ENVR-205C

**ENVR-305 Intro to Soil Sciences 3 Credits**

Quantitative study of the chemistry of the solid, liquid, and gas phases in soils and sediments. Topics include solid and solution speciation, mineral solubility, ion exchange and adsorption reactions, oxidation-reduction, and the chemistry of organic contaminants and toxic trace elements in soil. Lecture, 3 hours.

**ENVR-305L Intro to Soil Sciences Lab 1 Credit****ENVR-320 Hydrology 3 Credits**

Introduction to the scientific study of the hydrologic cycle. Covers the measurement and evaluation of hydrologic phenomena including the use of statistical methods. Explores computer techniques in hydrology with applications to water resource development and water quality problems, particularly those in California. Lecture, 3 hours.

**ENVR-335 Intro to Atmospheric Sciences 3 Credits**

Covers the structure of the atmosphere and man's impact upon it, especially the causes and consequences of air pollution. Addresses air quality standards and the stratospheric and tropospheric ozone. Also introduces the chemistry of air pollution and air pollution control strategies. Lecture, 3 hours.



**ENVR-405 Intro to Geo Info System (GIS) 3 Credits**

In this introductory course, students become familiar with the hardware and software components of a Geographic Information System and review GIS applications. Topics include data structures and basic functions, methods of data capture and sources of data, and the nature and characteristics of spatial data and objects. Topics covered include the fundamentals of data structures, georeferencing, data classification, querying, cartography, and basic spatial data analysis. The course provides an overview of the capabilities of GIS software and applications of GIS. Class time is divided between lectures and GIS exercises that reinforce critical concepts. Students must complete a term project as part of the course and should appreciate the utility of Geographic Information Systems in decision-making. Lecture, 3 hours.

Prerequisite: ENVR-150C; or permission of instructor

**ENVR-430 Environmental Policy and Impact Analysis 3 Credits**

Explores the principles and theories of analyzing environmental interactions. Provides a critical analysis of methodologies for assessing the physical, biological, and social impacts on the environment by human activities. Synthesizes the subject matter through preparation of an environmental impact report. Lecture, 3 hours.

**ENVR-499C Capstone Seminar/Environmental Studies 2 Credits**

This course includes a senior thesis covering an approved research topic, analysis and evaluation of current research in the environmental sciences, and the integration of faith and the sciences. An oral presentation of the senior thesis in a classroom setting is required. In-class presentations by faculty and guests are part of the course. Laboratory research in an on-campus research program or an approved off-campus research program may be required for the senior thesis. This course fulfills the Core Curriculum Capstone requirement for Environmental Science majors.

