

Department of Natural Sciences

Professors: Stuart I. Cromarty, Edward J. Dix (Chairperson), Brian K. Niece, Owen D.V. Sholes, Steven J. Theroux; *Associate Professors:* Elizabeth A. Colby Davie, David Crowley, Aisling S. Dugan, Georgi Y. Georgiev, James F. Hauri, Michele L. Lemons, Kimberly A. Schandel; *Assistant Professors:* Karolina Fucikova, Benjamin J. Knurr, Laura Marcotte, Jessica A. McCready; *Visiting Instructors:* Elissa Kraus, Anthony Sacino; *Lecturers:* Soraya Betancourt-Calle, Arthur LaPlante, Mary Lou Lombardi-Butler, Sandra Nedelescu, Hubert G. Meunier (Professor *Emeritus*).

MISSION STATEMENT

The Department of Natural Sciences is dedicated to preparing students to live and work in a changing world by ensuring competency in the natural sciences and scientific inquiry. The department strives to provide a basic understanding of classical and contemporary scientific concepts in these areas. While developing an understanding of the scientific process and its application, the following critical skills are stressed: observation, inquiry, data collection, analysis, communication, and correlation of scientific concepts. The department prepares students for careers and professional opportunities in the sciences as well as for life-long learning in the context of a liberal arts curriculum in the Catholic tradition.

PROGRAMS OF STUDY AND CAREER OPTIONS

The Department of Natural Sciences offers majors in Biology, Biology with a Concentration in Neuroscience and Behavior, Biotechnology and Molecular Biology, Neuroscience, Chemistry, Environmental Science, and Environmental Science with a Concentration in Environmental Policy. The Department also offers minors in Biology, Environmental Science, Chemistry, and Physics, and it co-sponsors a concentration in Physical and Occupational Therapy with the Department of Human Services and Rehabilitation Studies. Research opportunities are available at the College and at nearby institutions (e.g., University of Massachusetts Medical School and the Biotechnology Park). Students interested in teaching science in the public school system should work with a science faculty member and a member of the Education Department in planning their course of study. The Department also offers courses for non-majors.

Students who want to pursue careers in medicine, dentistry or one of the many other health professions must complete the necessary prerequisites for admission to the health profession schools of their choice. These individuals should consult their academic advisors and the Health Professions Advisor (Dr. Steven Theroux) when designing their course of study. The Health Professions Program helps students meet the admissions requirements for these professional programs. The Department has agreements with several institutions that offer degrees in the health professions. Students interested in Allopathic or Osteopathic Medicine, Podiatric Medicine, Pharmacy, Physical Therapy, Optometry, Physician Assistant Studies, Nursing, or Biotechnology should discuss these agreements with the Health Professions Advisor, Professor Steven Theroux.

The College has established a collaborative program of study in Engineering with the University of Notre Dame. Students spend three years at Assumption College completing foundational courses in math and science before transferring to Notre Dame to complete engineering studies. Interested students should contact Professor Jimmy Hauri, Director of the 3:2 Engineering Program.

The College also has agreements with several graduate schools. In conjunction with Duke University we offer combined B.A. and Master's degree programs in Environmental Science Management and Forestry Management. There are several options for students interested in the legal profession, especially those interested in practicing environmental law or intellectual property law. Science students interested in the learning more about all of these programs should see Professor Steven Theroux.

The Department offers a post-graduate program for those who have a bachelor's degree in an area other than Biology and who are interested in pursuing admission to a health professions program (e.g., medicine, dentistry, pharmacy, etc.) Details about this certificate program can be obtained from the Health Professions Advisor, Dr. Steven Theroux.

Students who graduate with an undergraduate degree in science can pursue employment in industry, government, or in an educational setting. Some of our students pursue graduate studies in science, one of the health professions, business or law.

Upon the completion of the appropriate graduate program our students can pursue research careers in environmental management, or in the biotechnology, pharmaceutical and chemical industries. They can also develop careers in elementary, secondary and higher education, or in the health professions, business management, government, or legal profession.

MINOR IN ENGINEERING SCIENCE (6)

This minor is for students who are interested in gaining a foundation in engineering, but do not wish to transfer to one of our 3-2 engineering partner schools. Students who do transfer to a partner school and graduate with an engineering degree are not eligible for the minor. The minor is a good option for those considering obtaining a graduate degree in engineering. The minor consists of 6 courses:

REQUIRED COURSES

PHY 213 Introduction to Engineering Problem Solving

MAT 355 Differential Equations

CSC 117 Introduction to Programming

PHY 301 Statics

2 electives (must be from different disciplines)

MAT 356 Numerical Analysis

CSC 317 Java Programming

PHY 275 Applied Optics

PHY 302 Dynamics

CHE 311 Physical Chemistry I or equivalent Thermodynamics course

Approved engineering courses, transfer credit or HECCMA consortium

STUDENT RESEARCH—SUMMER OPPORTUNITIES

Department faculty members oversee research programs on campus that engage upper-level students in the projects associated with their research interests. Summer research positions that provide a stipend are available on a competitive basis. Assumption students have been accepted into prestigious summer research programs at major research institutions around the country. The sponsoring institutions for this research include the National Science Foundation, the National Institutes of Health, and the American Cancer Society.

ARTICULATION AGREEMENTS IN THE SCIENCE AND HEALTH PROFESSIONS

Assumption College holds a wide range of agreements with graduate institutions in the health sciences. For a complete list, including agreements with law schools and Notre Dame's College of Engineering, see the "Cooperative Programs of Study and Agreements" section of the catalog and contact the Health Professions Advisor, Prof. Steven Theroux, stheroux@assumption.edu.

Massachusetts College of Pharmacy and Health Sciences B.A./Bachelor of Science in Nursing (B.S.N.)

The Massachusetts College of Pharmacy and Health Sciences (MCPHS) has agreed to provide at least three seats at their Manchester, NH campus and three seats in their Worcester, MA campus for qualified Assumption students who want to earn a Bachelor of Science in Nursing. To qualify for one of the limited number of guaranteed seats, Assumption students must complete the specified prerequisites with a grade of C or better (with no repeats), earn a cumulative GPA of 3.2 in the required prerequisites, and obtain a GPA of 3.2 or higher. Please see the Health Professions Advisor for additional details and requirements.

Massachusetts College of Pharmacy and Health Sciences B.A./Doctor of Pharmacy (Pharm.D.)

The Massachusetts College of Pharmacy and Health Sciences (MCPHS) has agreed to provide two seats at their Manchester, MA campus and five seats at their Worcester, MA campus for qualified Assumption students who want to enter an accelerated doctoral program in pharmacy. To qualify for admission into this 34-month course of study, Assumption students must complete the required prerequisites with a grade of C or better (no repeats). They must also have a GPA of 3.4 in the required prerequisites and an overall GPA of 3.4.

Massachusetts College of Pharmacy and Health Sciences B.A./Master of Science in Physician Assistant Studies (M.S.P.A.S.)

The Massachusetts College of Pharmacy and Health Sciences (MCPHS) has agreed to provide at least one seat at their Manchester, MA campus and one seat at their Worcester, MA campus for qualified Assumption students who want to earn a master's degree in Physician Assistant Studies. This is a 24-month program, and to qualify for one of the limited seats, Assumption students must complete the prerequisites with a grade of C or better (with no repeats). They must also have a GPA of 3.4 in the required prerequisites, an overall GPA of 3.4, and they must pass an interview at MCPHS.

New York Chiropractic College (NYCC) B.A./Doctor of Chiropractic (D.C.)

There are two options at NYCC for Assumption students interested in pursuing a doctorate in Chiropractic.

Traditional Doctoral Program (D.C.) Five seats are available at NYCC each year for qualified Assumption students who want to enter a doctoral program in Chiropractic.

Accelerated Doctoral Program (D.C.) Qualified Assumption students are also eligible to enter an accelerated program of study at NYCC. This course of study allows qualified students to complete a doctorate in chiropractic in six years of study instead of the typical seven.

Barry University B.A./Doctor of Podiatric Medicine (D.P.M.)

Assumption College and Barry University School of Podiatric Medicine have agreed to cooperate in providing an accelerated, seven-year curriculum of undergraduate and professional education leading to the Bachelor of Arts degree with a major in Biology from Assumption College and the Doctor of Podiatric Medicine degree from Barry University School of Podiatric Medicine. Upon successful completion of their first year at Barry University College of Podiatric Medicine, individuals in this program are eligible to graduate with a bachelor's degree from Assumption College. Admission into the School of Podiatric Medicine is not guaranteed.

New England College of Optometry B.A./Doctor of Optometry (O.D.)

Assumption College and the New England School of Optometry have agreed to cooperate in providing an accelerated, seven-year curriculum of undergraduate and professional education leading to the Bachelor of Arts degree with a Major in Biology from Assumption College, and the Doctor of Optometry degree from the New England College of Optometry. The program consists of a three-year curriculum at Assumption College followed by a four-year curriculum in optometry at the New England School of Optometry. Upon successful completion of their first year at the New College of Optometry, individuals in this program are eligible to graduate with a bachelor's degree from Assumption College. Admission into the School of Optometry is not guaranteed.

Massachusetts College of Pharmacy and Health Sciences B.A./Doctor of Optometry (O.D.)

The Massachusetts College of Pharmacy and Health Sciences (MCPHS) has agreed to provide five seats at their Worcester, MA campus for qualified Assumption students who want to earn a Doctorate in Optometry. To qualify for admission, students must complete the required prerequisites with a grade of C or better (no repeats). They must also have a GPA of 3.2 in the required prerequisites and an overall GPA of 3.2, and they must pass an interview at MCPHS.

Regis College M.S.in Molecular Imaging and Therapeutics

Regis College has reserved two seats for Assumption students who want to enter the Molecular Imaging and Therapeutics M.S. program. To be eligible, Assumption students must complete the prerequisite courses, and they must have a minimal GPA of 3.0. Eligible students receive waivers for the GRE/MAT requirement and the application fee. The top two eligible candidates are also given preferred admission without the competition of the rest of the applicant pool. Prior to starting the program the accepted student must earn a B.A. at Assumption College. For more information, see the Health Professions Advisor, Prof. Steven Theroux.

Northeastern University Graduate School

Northeastern University will reserve space for two qualified Assumption College students in its Master of Science in Biotechnology program. The minimum requirements for acceptance include a GPA of 3.2, satisfactory completion of all prerequisites, and a completed application. The GRE and application fee will be waived for these students. In addition, Northeastern University will waive the application fee and the GRE requirement for qualified Assumption College students who are interested in pursuing graduate studies in Biotechnology, Pharmaceutical Science, Physician Assistant Studies, Health Informatics, Public Health, Exercise Physiology and School Counseling. The minimal requirements for these waivers include a GPA of 3.2.

Duke University Marine Sciences Education Consortium (MSEC)

Assumption students are eligible to study at Duke University's Marine Laboratory in Beaufort, North Carolina. The Duke program offers an opportunity for intensive study in marine science and marine ecology. In addition, Assumption students may participate in the MSEC's study abroad programs which include sites in Singapore, Trinidad, Hawaii, Panama and France. This program should be of particular interest to Environmental Science majors and minors and to those who seek a science-intense study abroad opportunity.

Duke University 3:2 Program in Environmental Science Management and Forestry Management

Students interested in pursuing a master's degree from Duke University in Environmental Science Management (MEM) or Forestry Management (FM) can complete their general education requirements, their major requirements, and their application for admission to the Duke graduate school in three years. If accepted into the Duke professional master's degree program, the student is eligible to receive his or her Assumption College undergraduate degree upon the successful completion of their first year of graduate studies at Duke. At the end of the second year of graduate study, the student is eligible to receive the MEM or the FM from the Nicholas School at Duke University. The Duke agreement does not guarantee that Assumption College students will be accepted into the graduate program, and admission is competitive.

The University of Notre Dame B.S. in Engineering

Assumption College has established an agreement with the University of Notre Dame College of Engineering that allows qualified Assumption students to earn a B.A. in Chemistry, Environmental Science, Mathematics or Computer Science from Assumption College and a B.S. in one of several fields of Engineering from the University of Notre Dame. This program is a 3:2 program, which means students spend three years studying at Assumption College followed by two years at Notre Dame. Contact Professor Joseph Alfano for more information.

Washington University at St. Louis B.S. in Engineering

Assumption College and Washington University offer a 3:2 engineering degree that leads to a B.A. from Assumption and a B.S. in one of several fields of engineering. This program is very similar to the University of Notre Dame's 3:2 degree program described above. To participate a student must have a 3.25 GPA, and admission to Washington University is not guaranteed. Assumption College and Washington University also offer a 3:3 option for those seeking to earn a Master's Degree in Engineering. Students in this course of study spend three years at Assumption College and three years at Washington University, and upon completion they are awarded a B.A. from Assumption College and a Masters in Engineering from Washington University. Participation in the 3:3 program also requires the student to maintain a 3.25 GPA while at Assumption, and admission to Washington University is not guaranteed. Washington University has a highly-regarded and nationally ranked

engineering program, and qualified students who enter the 3:2 or 3:3 programs can choose to study Biomedical Engineering, Chemical Engineering, Computer Engineering, Electrical Engineering, Mechanical Engineering or Systems Science and Engineering. Students entering the 3:2 or 3:3 programs are eligible for financial aid from Assumption College and Washington University. For more information contact Prof. James Hauri at 508 767-7359.

POST-BACCALAUREATE CERTIFICATE PROGRAM IN PREREQUISITES FOR PROFESSIONAL SCHOOLS IN HEALTH FIELDS

This program is designed for individuals who hold Bachelor's degrees, who have not previously made application to Professional Schools in the Health Professions, and who are seeking to complete prerequisites before making an application. Participants will have "non-matriculating" status, and will be charged tuition and fees at the rate listed in the catalog. All courses will be taken with undergraduate students. Programs will be planned in consultation with the College's Advisor for the Health Professions, Dr. Steven Theroux. A participant must complete at least four courses with three different faculty members in the Department of Natural Sciences at Assumption in order to earn a certificate and a recommendation from the Recommendation Committee for the Health Professions. Applicants need to submit a completed application form, available from Dr. Steven Theroux, a written statement describing their motivation for the chosen health career, and official undergraduate transcripts. To be applicants get a seat in the courses that they need to take, these applications should be completed by the end of February prior to their Fall attendance. Completion of this certificate does not guarantee admission to a professional school.

Course Descriptions

CHEMISTRY (CHE)

CHE 105 EVERYDAY CHEMISTRY

This course is designed for non-majors to better understand the chemistry that they interact with in their everyday lives. Even though chemistry has a constant and ubiquitous impact on our lives, most people are unaware of the science behind the products that they use every day. Emphasis will be on the connection between fundamental chemical properties and concepts and the student's everyday lives. Topics will be organized around the chemistry seen in different household areas such as the kitchen, bathroom, laundry room, and garage. There is \$200 lab fee associated with the course. Counts as a science in the NEW core starting with the Class of 2020. This course is NOT eligible to count as a science with a lab under the OLD core.

Hauri/Three credits

CHE 131–132 GENERAL CHEMISTRY I AND II

Fundamental principles of chemistry. Topics covered in CHE 131 include: matter and measurement, atomic and electronic structure, stoichiometry, gases, bonding, and solutions. In CHE 132: chemical equilibria (gases, solubility), acids and bases, electrochemistry, thermochemistry, nuclear and coordination chemistry. Emphasis is placed on problem solving. Laboratory work includes Qualitative Analysis. CHE 131 is a prerequisite for CHE 132. Intended science majors should take this series in their first year. Lab Fee: \$400.00 each semester. This course fulfills the Core Curriculum requirement for a science with a lab. (Part I, Fall; Part II, Spring.) Pre-requisite: MAT 114.

Hauri, Knurr, Marcotte, Niece /*Four credits each semester*

CHE 201–202 ORGANIC CHEMISTRY I AND II

The chemistry of organic compounds (the compounds of carbon) is studied. The topics include covalent bonding, molecular structure, and resonance; constitutional, geometric, and optical isomerism; the reactions of organic compounds through their functional groups; the nucleophilic, electrophilic, and free radical reaction mechanisms; and spectroscopy. These theoretical and practical principles are applied to the solution of such organic chemical problems as structure determination, chemical synthesis of desired molecules, the effect of structure on properties, and the biological roles of organic molecules. This full-year course meets the needs of students who expect to pursue graduate studies in natural sciences and also of those who plan to enter professional schools. Prerequisite: CHE 131–132. Lab Fee: \$400.00 each semester. (Fall, Spring)

Colby Davie, Dix/*Four credits each semester*

CHE 275 SPECIAL TOPICS IN CHEMISTRY

This special topics course will explore an area of chemistry using the literature, and if appropriate, a cross-disciplinary approach. The course will allow the students and faculty an opportunity to investigate areas of chemistry that are not part of the regular curriculum.

Staff/Three credits

CHE 291 INTERNSHIP IN CHEMISTRY

Directed study within an internship program. The student will be expected to keep a journal detailing the internship. The student will also be expected to write a paper (usually approximately 10 pages in length) summarizing an area related to the internship experience. An evaluation by the on-site supervisor will be considered when determining the grade. The student will be required to have a G.P.A. of 3.0 to enroll.

CHE 311–312 PHYSICAL CHEMISTRY I AND II

An intensive study of the structure and interconversions of matter in its several states. Intra- and inter-molecular forces, thermodynamics, equilibria, electrochemistry, kinetics, and statistical and quantum mechanics are considered. Prerequisites: CHE 201–202, PHY 201–202 (may be concurrent with permission of instructor), MAT 117–118 or MAT 131–132 or permission of the instructor. Lab Fee: \$400.00 per semester. (Fall, Spring)

Knurr/Four credits each semester

CHE 315 ANALYTICAL CHEMISTRY

A study of the major methods of chemical analysis, including statistics in evaluating the error associated with measurements, the systematic treatment of acid-base equilibria, introductory electrochemistry and spectrophotometry, and the theory of separations (chromatography). Three lectures and one three-hour laboratory per week. Prerequisite: CHE 201–202. Lab Fee: \$400.00. (Fall, odd-numbered years)

Niece/Four credits

CHE 316 INORGANIC CHEMISTRY

A study of the structure and properties of the elements and their compounds. Topics covered are atomic structure, periodic relationships, molecular bonding, acid-base systems, and coordination compounds. Laboratory work focuses on the interaction between experiment and theory in understanding and predicting chemical phenomena. Three lectures and one laboratory period per week. Prerequisite: CHE 201–202. Lab fee: \$400.00. (Fall, even-numbered years)

Niece/Four credits

CHE 318 ENVIRONMENTAL CHEMISTRY

A specialized knowledge of chemistry is needed in order to identify, understand, and solve environmental problems. This course will be an in depth study of the chemistry of environmental issues and pollutants. Students will learn the mechanisms of important chemical reactions, as well as relevant analytical techniques related to environmental chemistry. In the lab, students will combine field work, analytical chemistry, and remediation techniques during their investigation of environmental problems. Prerequisites: CHE 131–132, CHE 201–202. Lab Fee: \$400.00

Hauri/Four credits

CHE 414 BIOCHEMISTRY

The major classes of biochemicals, carbohydrates, proteins, lipids, and nucleic acids are studied with particular attention to the relationship between their chemical structures and biological functions. Specific topics include (but are not limited to) biocatalysis, receptors, membrane structure, metabolism, biosynthesis, and energy production. Prerequisite: CHE 201–202 and BIO 160. Lab Fee: \$400.00. (Fall, Spring)

Marcotte, Schandel/Four credits

CHE 416 MOLECULAR STRUCTURE AND CHARACTERIZATION

A detailed study of current chemical bonding theories and characterization techniques. Topics covered include molecular symmetry, molecular orbital theory, and computer molecular modeling. Molecular characterization with electronic, vibrational, and nuclear magnetic resonance spectroscopies is addressed. Laboratory work includes molecular modeling, NMR, UV/Visible, and IR Spectroscopy. Three lectures and one laboratory period per week. Prerequisites: CHE312 (can be concurrent with instructor's permission, CHE316. Lab Fee: \$400.00 (Spring, odd-numbered years)

Niece/Four credits

CHE 450 INSTRUMENTAL CHEMISTRY

The study of the theory of instrumental methods of analysis and their application in the laboratory. Topics include computers in data collection and management, UV-vis, IR, AA, fluorimetry, and electrochemical methods. In addition, NMR and mass spectrometry are covered in the lecture. Two lectures and one laboratory period per week. Prerequisite: CHE 202 or permission. Lab Fee: \$400.00. (Spring, even-numbered years)

Niece/Four credits

CHE 460 MEDICINAL CHEMISTRY

Natural and synthetic medicines are investigated with attention to their fate in a living organism: absorption, distribution, and elimination; dose-response and time-response relationships of drugs; and the relationship between chemical structure and biological activity. The biochemistry of several diseases (probably including AIDS) will be examined to learn different ways that chemicals can be used to interfere with the course of a disease. Prerequisite: CHE 201–202 and BIO 160. (Spring, even-numbered years)

Dix/Three credits

CHE 470 ADVANCED ORGANIC CHEMISTRY

An advanced course surveying modern organic chemistry. Topics include synthetic methods, mechanistic analysis, isotope effects, pericyclic and photochemical reactions, and electron transfer. Several case studies will be used to illustrate these topics. Three lectures per week. Prerequisites: CHE 201–202 and CHE 311 or CHE 313. (Spring, odd-numbered years)

Colby Davie/Three credits

CHE 480 SEMINAR IN CHEMISTRY

The student researches specified areas of Chemistry under the guidance of faculty members for oral presentation and defense before the class. Written papers are submitted for final review. Offered upon sufficient demand. Prerequisites: six courses in Physics and Chemistry.

Staff/Three credits

CHE 491–492 INDEPENDENT STUDY

Directed study and research in some aspect of chemistry. Open to students who have a minimum GPA of 3.0 and at least six courses in chemistry or other science. Offered by arrangement with a faculty member. (Fall, Spring)

Staff/Three credits each semester

PHYSICS (PHY)

PHY 112 INTRODUCTION TO ASTRONOMY

Introduction to stars, galaxies, and clusters of galaxies; earth, moon, planets, and comets; origin, life cycle, and death of both planetary and galactic systems; theories of the origin, structure, and end of the universe. The laboratory familiarizes the student with the tools of the astronomer and with the analysis of data. No prerequisite. Lab Fee: \$400.00. This course fulfills the Core Curriculum requirement for a science with a lab. (Fall)

Staff/Four credits

PHY 201 GENERAL PHYSICS I

This course explores mechanics and heat. Three lectures and one laboratory period. Prerequisite: MAT 114 or Calculus (may be concurrent). Lab Fee: \$400.00 per semester. This course fulfills the Core Curriculum requirement for a science with a lab. (Fall)

Georgiev/Four credits each semester

PHY 202 GENERAL PHYSICS II

This course explores sound, electricity, magnetism, and light. Three lectures and one laboratory period. Prerequisite: PHY 201 and MAT 114 Elementary Functions or MAT117 Calculus I (may be concurrent). Lab Fee: \$400.00 per semester. This course fulfills the Core Curriculum requirement for a science with a lab. (Spring)

Georgiev/Four credits each semester

PHY 213 INTRODUCTION TO ENGINEERING PROBLEM SOLVING

This introductory course is designed to acquaint students with the variety of engineering disciplines, as well as provide students with the basics of the engineering mindset. The ability to develop and resolve solutions to applied problems is a necessary skill

for a multitude of disciplines. The structure of the course emphasizes group projects and the use of computers to create models to solve problems. Prerequisite: Mat117/131 and Mat118/132 (can be taken concurrently). (Spring)

Hauri/*Three credits*.

PHY 275 APPLIED OPTICS

The course investigates the general methods and applications of optics within the natural sciences. We will consider the optics of waves, the electromagnetic nature of light, reflection and refraction, interference and diffraction, polarization and geometrical optics, and optical instruments widely used in the natural sciences. Lab Fee \$400.00. Prerequisites: PHY 201, PHY 202 and MAT 114 or MAT117.

Georgiev/*Three credits*

PHY 301 MECHANICS I: STATICS

The goal will be to endow students with a fundamental understanding of the engineering mechanics of static objects and fluids. Students will emerge proficient in problem solving, application of physical mechanical principles and critical thinking skills. This will be the first course in a year-long sequence on engineering mechanics. Topics to be covered include: Vector Algebra/Calculus, Vector forces and moments in 2-D and 3-D systems, Equivalent systems of forces, Equilibrium of rigid bodies, Centroids, centers of gravity, and distributed forces, Trusses, frames, machines: two-force and multi-force members, Beams: internal forces, shear and bending moment diagrams, Dry friction, Wedges and screws, Moments of inertia, Fluid Statics, Virtual work mechanics essentials.

PHY 302 MECHANICS II: DYNAMICS

This course is a 3 credits course, the second in a year-long sequence on engineering mechanics, the first being statics, a required sequence for most engineering tracks. Students will explore the fundamentals of physical-mechanical principles and apply them to the dynamics of objects and fluids. Topics to be covered include: friction forces and spring forces, power, work, and energy, momenta, impulses, and collisions, dynamics of systems of particles, kinetics of a rigid body, fluids. This course is only offered in the spring, every other year. There is no lab requirement for this course.

PHY 480 SEMINAR IN PHYSICS

The student researches specified areas of physics under the guidance of faculty members for oral presentation and defense before the class. Written papers are submitted for final review. Offered upon sufficient demand. Prerequisites: Six courses in physics and chemistry. (Spring)

Staff/*Three credits*

PHY 491–492 INDEPENDENT STUDY

Directed study in an area of Physics. The course is open to students who have completed a minimum of six science courses and have a GPA of 3.0 or higher. Offered by arrangement. (Fall, Spring)

Staff/*Three credits*