

CHEMISTRY AND PHYSICS

Head of the Department: Associate Professor Blanchard

Professors: Doughty, McCarthy, Munchausen

Associate Professors: Allain, Elbers, Norwood, Parkinson, Temple, Yoshida

Assistant Professors: Chou, Dolliver, Fotie, Kim, Li, Li, Sommerfeld, Voegel

Instructors: Ladogana, Neylon

Corresponding lecture and laboratory courses numbered below 400 must be scheduled concurrently unless prior credit has been received for either the lecture or the laboratory.

Credit toward the degree will not be granted for corresponding lecture and laboratory courses numbered below 400 until both lecture and laboratory courses have been successfully completed unless permission to do otherwise has been obtained from the Department Head. Such permission will be granted only in unusual circumstances.

Students who violate the laboratory safety policy of the Department are subject to dismissal from the laboratory and withdrawal from the course.

Credit toward the degree will be granted for only one of the Chemistry courses in each of the following combinations: 101-106-109-121, 102-122, 103-123, 104-124, 261-265, 263-267, 281-481, 283-485.

Credit toward the degree will be granted for only one of the Physics courses in each of the following combinations: 142-191-221, 192-222, 193-223, 194-224.

CHEMISTRY (CHEM & CLAB)

¹May not be used as credit toward a major or minor in Chemistry and may not be used to fulfill prerequisites for any other chemistry course.

101. General Chemistry I. Credit 3 hours. Prerequisites: An Enhanced ACT standard score in Mathematics of 19 or greater or concurrent registration in or prior credit for Mathematics 155 or 161. The first of a two semester sequence covering the following general topics: metric and temperature conversions, density, calorimetry, mixtures/compounds/elements, chemical and physical properties, structure of the atom and electron configuration, periodic table, bonding, chemical formulas and nomenclature, moles, stoichiometry, chemical reactions, gas laws, and properties of gases, liquids and solids. This course is not recommended for students whose curricula require Chemistry 251, 254, 265, 266, and courses numbered above 300.

102. General Chemistry II. Credit 3 hours. Prerequisite: Chemistry 101. A continuation of Chemistry 101 covering topics such as: solutions, concentrations (% composition and molarity), acids/bases, pH, buffers, kinetics, equilibrium, solubility, oxidation/reduction, nuclear chemistry, and an introduction into organic chemistry and biochemistry. This course is not recommended for students whose curricula require Chemistry 251, 254, 265, 266, and courses numbered above 300.

103. General Chemistry Laboratory I. Credit 1 hour. Prerequisite: Registration in or prior credit for Chemistry 101. A series of laboratory experiments designed to illustrate the material studied in Chemistry 101 covering such topics as density determination, chromatography, calorimetry, emission spectra, gas laws, chemical changes and data collection. Two hours of laboratory per week. Laboratory fee: \$30.00.

104. General Chemistry Laboratory II. Credit 1 hour. Chemistry Lab 103 and registration in or prior credit for Chemistry 102. A continuation of Chemistry Lab 103 covering data collection, solutions chemistry, graphing, colligative properties, titrations, acid-base reactions, limiting reagents, kinetics, equilibrium, oxidation-reduction, organic chemistry syntheses, and qualitative analysis of inorganic and organic substances. Two hours of laboratory per week. Laboratory fee: \$30.00.

105.¹ Forensic Science. Credit 4 hours. Scientific aspects of law enforcement; role and functions of the crime laboratory. This course may not be used to satisfy the General Education sequence requirement in the Natural Sciences. Course consists of four hours of lecture and demonstrations a week.

106.¹ Chemistry for the Consumer. Credit 4 hours. A survey course in the cultural and applied aspects of chemistry designed primarily for students majoring in the Colleges of Business, Education, and the humanities portion of the College of Arts and Sciences. This course may not be used to satisfy the General Education sequence requirement in the Natural Sciences. Course consists of four hours of lecture and demonstrations per week.

109. Chemistry for Non-Science Majors. Credit 3 hours. A survey course in the cultural and applied aspects of chemistry designed primarily for students majoring in a non-science degree. This course may be used to satisfy the General Education sequence requirement in the Natural Sciences when taken with Physical Science 101. Credit cannot be given for both Chemistry 109 and Physical Science 102. Course consists of three hours of lecture and demonstrations per week.

112. Chemistry of Art. Credit 3 hours. Prerequisites: C or better in Math 155 or 161. A course designed for majors in Visual Arts. Others may enroll with permission of the Chemistry and Physics Department Head. This course studies the fundamentals of chemistry and scientific principles as they relate to art, art media, and art history. These scientific fundamentals will be used to explain how art objects are observed, composed, manufactured, forged, and conserved. Includes regular hands-on learning sessions. This one-semester course may be used to satisfy the General Education requirement in the Natural Sciences.

121. General Chemistry I for Science Majors. Credit 3 hours. Prerequisites: Enhanced standard Act Math score of 21 or completion of Math 155 or 161 or Math 165. First semester chemistry course designed for natural engineering or life sciences majors. Topics include nomenclature, atomic and molecular structure, chemical equations and stoichiometry, and gas laws.

122. General Chemistry II for Science Majors. Credit 3 hours. Prerequisite: Chemistry 121. A continuation of Chemistry 121. Topics include intermolecular forces, properties of solutions, kinetics, equilibria, acids and bases, chemical thermodynamics, and electrochemistry.

123. General Chemistry Laboratory I for Science Majors. Credit 1 hour. Prerequisite: Registration in or prior credit for Chemistry 121. This laboratory course is designed to illustrate materials studied in Chemistry 121. Experiments involve mass/volume measurements and relationships, yield and stoichiometry, calorimetry and thermochemistry, and the manipulation and measurement of gases. Three hours of laboratory per week. Laboratory fee: \$30.00.

124. General Chemistry Laboratory II for Science Majors. Credit 1 hour. Prerequisites: Chemistry Laboratory 123 and registration in or prior credit for Chemistry 122. This laboratory course is designed to illustrate materials studied in Chemistry 122. Experimental methods include quantitative, gravimetric and volumetric analysis, electrochemistry, plus kinetics with computer analysis of experimental data. Three hours of laboratory per week. Laboratory fee: \$30.00.

150. Chemical Information Sources. Credit 2 hours. Prerequisite: Must be taken concurrently with either CHEM 121, 122, 251, or 265. Designed to enable chemistry majors to efficiently retrieve, organize, evaluate, and utilize information from traditional and emerging information sources. Includes instruction in the use of on-line databases. Two hours of lecture per week.

211. Introduction to Chemistry Research. Credit 1 hour. This course is open to all students. Prerequisite: Consent of faculty mentor and Department Head. This course will teach the fundamental skills necessary to conduct chemical research. This course is given as pass/fail only. Three contact hours per week. Laboratory fee: \$30.00.

251. Analytical Chemistry. Credit 3 hours. Prerequisites: Chemistry 122/124. This course examines the analytical process from method selection and sample preparation to interpretation and presentation of results focusing primarily on wet chemical methods of quantitative analysis. In depth theoretical and practical aspects of equilibria and complexation chemistry, volumetric and gravimetric analyses, potentiometry, basic spectroscopy, and statistical analysis are included.

254. Analytical Chemistry Laboratory. Credit 2 hours. Prerequisites: Chemistry 122/124 and concurrent enrollment or prior credit for Chemistry 251. This laboratory course emphasizes classical methods of quantitative analysis. Experimental methods include volumetric titration, gravimetric analysis, and elementary spectroscopy and potentiometry. Statistical treatment of data and presentation of results are essential. Four hours of laboratory per week. Laboratory fee: \$30.00.

261. Survey of Organic Chemistry. Credit 3 hours. Prerequisites: Chemistry 102 or 122. An introduction to the nomenclature, preparation, properties, and reactions of organic compounds, with attention to biological significance. This course is designed for students in Biological and Applied Sciences who are required to take only one semester of organic chemistry.

263. Survey of Organic Chemistry Laboratory. Credit 1 hour. Prerequisites: Chemistry 102/104 or Chemistry 122/124 and registration in or prior credit for Chemistry 261. Designed to acquaint the student with some of the important laboratory operations and techniques in organic chemistry. Two hours of laboratory a week. Laboratory fee: \$30.00.

265. General Organic Chemistry I. Credit 3 hours. Prerequisites: Chemistry 122. A study of the compounds of carbon, including nomenclature, properties, structure, stereochemistry, transformations and reactions of organic compounds; principles of organic reaction mechanisms; and the importance of organic chemistry in real world applications. This course is the first half of a two semester sequence and concentrates on the chemistry of alkanes, alkyl halides, alkenes, alkynes, and alcohols. A course designed for students in biological sciences, chemistry, and pre-professional curricula.

266. General Organic Chemistry II. Credit 3 hours. Prerequisite: Chemistry 265. A study of the compounds of carbon, including nomenclature, properties, structure, stereochemistry, transformations, synthesis and reactions of organic compounds; principles of organic reaction mechanisms; and the importance of organic chemistry in real world applications. This course is the second half of a two semester sequence and concentrates on the chemistry of alcohols, ethers, aromatics, ketones, aldehydes, amines, and carboxylic acids and their derivatives. A course designed for students in biological sciences, chemistry and pre-professional curricula.

267. General Organic Chemistry Laboratory I. Credit 1 hour. Prerequisites: Chemistry 124 and registration in or prior credit for Chemistry 265. A course designed to acquaint the student with basic organic laboratory techniques including recrystallization, melting point determination, extraction, distillation, and column, thin layer and gas chromatography as well as basic synthetic techniques. A course designed for students in biological sciences, chemistry, and pre-professional curricula. This course is the first half of a two semester lab sequence. Three hours of laboratory per week. Laboratory fee: \$30.00.

268. General Organic Chemistry Laboratory II. Credit 1 hour. Prerequisites: Chemistry 267 and registration in or prior credit for Chemistry 266. This course is the second half of a two semester lab sequence. A course designed to acquaint the student with synthetic techniques and structure determination techniques including classical qualitative analysis and spectroscopic analysis including NMR and IR. A course designed for students in biological sciences, chemistry, and pre-professional curricula. Three hours of laboratory per week. Laboratory fee: \$30.00.

281. Survey of Biochemistry. Credit 3 hours. Prerequisites: Chemistry 261 or 266. A one-semester survey of basic biochemistry covering the structures and functions of amino acids, proteins, enzymes, carbohydrates, lipids and nucleic acids, metabolism, and gene expression. Other topics include acid-base properties, buffers, enzyme kinetics, membrane structure and transport, and hormones. This course may not be used for a major or minor in chemistry.

283. Survey of Biochemistry Laboratory. Credit 1 hour. Prerequisites: Chemistry 263 and registration in or prior credit for CHEM 281. A one-semester laboratory to accompany Chemistry 281 covering such topics as biochemical techniques; buffering capacity; amino acid titrations; detection of proteins, carbohydrates and lipids; enzyme kinetics and inhibition; gene expression and metabolism. This course may not be used for a major or minor in chemistry. Two hours of laboratory per week: \$30.00.

290. Survey of Physical Chemistry. Credit 3 hours. Prerequisites: Chemistry 122/124, Physics 192/194, and Mathematics 163 or 200. An introduction to the structure and physical states (gaseous, liquid, and solid) of matter, properties of solutions, electrochemistry, kinetics, and chemical thermodynamics.

306. Special Topics in Science Education. Credit 1-3 hours. Prerequisites: Students must be education majors or elementary/secondary school teachers who have completed Chemistry 261/263 or have permission of the Department Head.

Chemistry 251/254 are strongly recommended. A reading course with topics and credit to be decided by agreement between the department and student. This course may be repeated for credit if different topics are studied.

335.¹ Chemistry Education Laboratory. Credit 3 hours. Prerequisite: Students must be science education majors who have completed Chemistry 261/263 or by consent of the Department Head. Chemistry 251/254 are strongly recommended. Experiments will be presented and performed that illustrate the theories of chemistry and that can be used as demonstrations. Theory will be presented and used in conjunction with experiments. Six hours of laboratory per week. Laboratory fee: \$30.00.

¹May not be used as credit toward a major or minor in Chemistry and may not be used to fulfill prerequisites for any other chemistry course.

391. Physical Chemistry Laboratory I. Credit 1 hour. Prerequisites: Chemistry 251/254 and Physics 221 and registration for or prior credit for Chemistry 395. Quantitative physical chemistry measurements, design and construction of apparatus and interpretation of data. Three hours of laboratory per week. Laboratory fee: \$30.00.

392. Physical Chemistry Laboratory II. Credit 1 hour. Prerequisites: Chemistry 395, Chemistry Lab 391, and registration for or prior credit for Chemistry 396. A continuation of Chemistry Lab 391. Three hours of laboratory per week. Laboratory fee: \$30.00.

395. Physical Chemistry I. Credit 3 hours. Prerequisites: Chemistry 122/124 and Physics 221. A calculus based study of physical chemistry. The two main topics of the course are (1) kinetics in the gas phase and in solution, and (2) quantum mechanics and its application to atoms and molecules.

396. Physical Chemistry II. Credit 3 hours. Prerequisite: Chemistry 395. Continuation of Chemistry 395. A study of thermodynamics, its statistical foundation in atomic and molecular structure, and its application to kinetics and the chemical equilibrium.

401/502. Chemistry Seminar. Credit 1 hour. Prerequisite: Senior standing in the Chemistry curriculum or permission of the Department Head. Attendance at departmental seminars, panel discussions, and related professional events and individual presentation of a topic of current research interest.

404/504. Special Topics in Chemistry. Credit 1-3 hours. A reading course with topics and credit to be decided by agreement between the Department and student. This course may be repeated for a maximum of 9 credit hours if different topics are studied.

410/510. Chemical Literature. Credit 1 hour. Prerequisites: Chemistry 266 or permission of the Department Head. Familiarization with and review of the chemical literature designed to serve as preparation for Chemistry 411.

411/511. Chemical Research. Credit 1-4 hours. Maximum credit four hours. Prerequisites: Prior credit for Chemistry 122/124 and Chemistry 211 (or equivalent research experience) and permission of Department Head. A course designed to give students experience in performing research in one of the fundamental areas of chemistry under the direction of a faculty mentor. Requirements include the keeping of an up-to-date laboratory notebook and the submission of a comprehensive final report. Three clock hours per week per credit hour. Laboratory fee: \$30.00.

412. Advanced Chemical Research. Credit 1-4 hours. Three in-lab hours per week per credit hours. Prerequisites: Chemistry 395 and 411 (or equivalent research experience) with consent of the faculty mentor and Department Head. A course designed to provide an environment for students to devise, develop, and carry out an independent research project containing a substantial amount of novelty or originality. The final semester of 412 will culminate with a comprehensive written project report. May be repeated for a total of six credit hours maximum. Laboratory fee: \$30.00.

452/552. Modern Instrumental Analysis. Credit 3 hours. Prerequisites: Chemistry 251, 254, and 266. This course provides a detailed examination of instrument components and design, methods of signal enhancement, methods of calibration, and spectral interpretation. Topics include advanced spectroscopy (AAS, FT-IR, UV-visible, and NMR), modern separations (GC, HPLC, ion chromatography and capillary electrophoresis), electroanalysis (voltammetry, amperometry, coulometry, and chemically and enzyme modified electrodes), and mass spectrometry.

453/553. Instrumental Analysis Laboratory. Credit 2 hours. Prerequisites: Chemistry Lab 268 and concurrent enrollment in or prior credit for Chemistry 452/552. This laboratory course emphasizes modern instrumental methods of analysis and hands-on operation of modern instrumentation. Experimental methods include spectroscopy, mass spectrometry, electroanalysis, and chromatography. Six hours of laboratory per week. Laboratory fee: \$30.00.

462/562. Physical Organic Chemistry. Credit 3 hours. Prerequisites: Chemistry 266/268 and 396. Quantitative mathematical approaches to organic mechanisms; structure related to reactivity.

471/571. Inorganic Chemistry. Credit 3 hours. Prerequisite: Chemistry 266 and Chemistry 395. Current theoretical models for correlation of inorganic systems; review of major chemical trends across periodic table; oxidation states of elements, oxidation-reduction equilibria, and introduction to acid-base equilibria. Introduction to inorganic stereochemistry including coordination compounds, group theory, organometallic compounds, and electron-deficient molecules.

474/574. Inorganic Chemistry Laboratory. Credit 2 hour. Prerequisites: Chemistry 266/268 and Chemistry 395 and registration in or prior credit for Chemistry 471. A course designed to acquaint the student with important laboratory operations and techniques in inorganic and organometallic chemistry. An emphasis will be placed on synthesis and characterization of compounds including the manipulation of air-sensitive materials. Four hours of laboratory per week. Laboratory fee: \$30.00.

481/581. Biochemistry I. Credit 3 hours. Prerequisites: Chemistry 266/268. A study of the structure and function of biological macromolecules with emphasis on proteins, enzymes, lipids, carbohydrates, and nucleic acids. A course designed for majors in biology and chemistry.

482/582. Biochemistry II. Credit 3 hours. Prerequisite: Chemistry 481/581. A continuation of Chemistry 481/581 with emphasis on gene expression and metabolism. A course designed for majors in biology and chemistry.

485/585. Biochemistry Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Chemistry 481. A laboratory to accompany Chemistry 481. Experiments are designed to demonstrate the properties of amino acids, proteins, carbohydrates, lipids, and nucleic acids with emphasis on enzyme kinetics and protein purification. Three hours of laboratory a week. Laboratory fee: \$30.00. Students taking this course for graduate degree credit must complete an independent research project and a written research paper summarizing the project.

486/586. Biochemistry Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Chemistry 482 and prior credit for Chemistry 485. A laboratory to accompany Chemistry 482. Experiments are designed to demonstrate some of the major metabolic pathways with emphasis on energy considerations and interrelationships of the pathways. It also emphasizes the flow of genetic information through replication, transcription, and translation. Three hours of laboratory a week. Laboratory fee: \$30.00. Students taking this course for graduate degree credit must complete an independent research project and a written research paper summarizing the project.

491/591. Theoretical Chemistry. Credit 3 hours. Prerequisites: Chemistry 396 and Physics 222/224. Advanced treatment of fundamental principles of physical chemistry. Selected topics chosen from electro-chemistry, photochemistry, surfaces and colloids, solid state chemistry, crystallography, solutions (ideal and real), and statistical thermodynamics.

492/592. Quantum Chemistry. Credit 3 hours. Prerequisite: Chemistry 491. Fundamental concepts of quantum mechanics with application to atomic and molecular structure, the chemical bond, symmetry, and spectroscopy.

554. Chemical Analysis for Teachers. Credit 3 hours. Prerequisites: Chemistry 122/124 and permission of the Department Head. A laboratory course to help science teachers understand the concepts of quantitative chemical analysis as used in the laboratory. The course is open only to secondary school teachers. Credit will not be given for both this course and Chemistry 254. Six hours of laboratory per week. Laboratory fee: \$30.00.

555. Qualitative Analysis for Teachers. Credit 3 hours. Prerequisites: Chemistry 122/124 and permission of the Department Head. A laboratory course designed to help science teachers understand the concepts of inorganic solution chemistry. This course is open only to secondary school teachers. Credit will not be given for both this course and Chemistry 253. Six hours of laboratory per week. Laboratory fee: \$30.00.

610. Chemical Processes. Credit 3 hours. Prerequisite: Chemistry 266 or equivalent. A course designed to study important chemical processes in industry. Examples from the commodity chemical, polymer, pharmaceutical and agricultural industries will be studied. The content will include basics in the scientific, legal, and economic issues associated with the industry such as petrochemical processing, costs, associated with raw materials, scale-up marketing, energy, and process waste.

621. Conceptual Frameworks in Introductory Chemistry I. Credit 3 hours. Prerequisite: Permission of the Department Head. This course will provide a rigorous treatment of conceptual frameworks in chemistry while modeling appropriate technologies and teaching methodologies. Three major themes will guide the course; the process of science, the relationship between molecular structure and physical/chemical properties; and the relationship between the macroscopic, microscopic, and symbolic representations of matter. Topics covered include atomic structure, molecular structure, solids and liquids, and stoichiometry.

622. Conceptual Frameworks in Introductory Chemistry II. Credit 3 hours. Prerequisite: Chemistry 621. This course will provide a rigorous treatment of conceptual frameworks in chemistry while modeling appropriate technologies and teaching methodologies. Three major themes will guide the course; the process of science, the relationship between molecular structure and physical/chemical properties; and the relationship between the macroscopic, microscopic, and symbolic representations of matter. Topics covered include equilibrium, acids and bases, oxidation-reduction, thermodynamics, and kinetics.

650. Environmental Chemistry. Credit 3 hours. Prerequisite: Chemistry 251 or equivalent. Critical phenomena in the environment will be studied. Topics include redox equilibria in natural waters, complexation in natural water, environmental chemistry of soil, atmospheric pollutants, and techniques for monitoring these phenomena. There will be a field component to this course.

EARTH SCIENCE (EASC & ESLB)

101. Earth Science I. Credit 3 hours. An elementary treatment of sun-Earth relationships and the solar and stellar system.

102. Earth Science II. Credit 3 hours. An elementary study of geology and oceanography.

103. Earth Science Laboratory I. Credit 1 hour. Prerequisites: Registration for or prior credit for Earth Science 101. A series of selected experiments to aid students in their understanding of meteorology and/or celestial mechanics. Two hours of laboratory a week.

104. Earth Science Laboratory II. Credit 1 hour. Prerequisites: Prior credit for Earth Science 103 and registration for or prior credit for Earth Science 102 or permission of the Department Head. A series of activities to aid students in their understanding of geological formations and processes. Two hours of laboratory a week.

142. Elementary Earth-Space Science. Credit 3 hours. Prerequisites: Education major, in-service teacher or permission of the Department Head. This course is designed to prepare prospective and in-service K-12 teachers to teach Earth and space science as a process of inquiry. The curriculum focuses on core concepts of earth and space science, and students will actively engage in a process of hands-on investigation and discovery in a laboratory setting. The primary objective is to provide a student-centered, active-learning environment that promotes critical thinking, collaborative learning, and an understanding and appreciation of the processes of scientific investigation. Three hours of integrated lecture and laboratory per week.

201. Earth Science III. Credit 3 hours. Prerequisite: Earth Science 101 and 103. A continuation of Earth Science 101. Emphasis will be on stars and stellar systems, stellar evolution, galactic structure and basic cosmology.

205. Special Topics in Earth Science. Credit 4 hours. Prerequisites: A 100 level Earth Science lecture and lab and permission of the Department Head. Selected topics in Earth Science that are new or unique and are not covered in existing courses. This course is designed primarily for education majors. This course is a guided inquiry approach to learning and also integrates a service-learning component. It is comparable to a three hour lecture/two hour laboratory per week course. This course may not be used to satisfy the General Education sequence requirement in the Natural Sciences. This course may be repeated, as topics vary, for a maximum of 12 credit hours.

PHYSICS (PHYS & PLAB)

100. Acoustics for Musicians. Credit 3 hours. Prerequisites: Mathematics 155 or 161, or Math ACT score of 20 or higher. The fundamentals of sound, waves and related phenomena for music majors. Three hours of lecture per week.

121. Elementary Modern Electronics. Credit 3 hours. Prerequisite: Registration for or prior credit for Physic 123. A course emphasizing circuit design with modern integrated circuit chips.

123. Elementary Modern Electronics Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Physics 121. A laboratory course involving the construction of radios, digital counters, clocks, frequency meters and other devices for electronic measurement and control.

130. Contemporary Physics Seminar. Credit 1 hour. This course is designed to convey an understanding of and appreciation for physics and science by finding their applications to specific objects of everyday experience, and their role in current events. Instead of starting with physics principles and working outward to the real world, students start by looking at familiar real-world objects. Seminars, reviews, and discussions by guest speakers, faculty, and students will be presented.

142. Elementary Physics. Credit 4 hours. Prerequisites: Education majors, inservice teachers, or permission of the Department Head. This course is designed to prepare preservice and inservice K-12 teachers to teach physical science as a process of inquiry. The curriculum will focus on small number of topics in elementary physics, and students will actively engage in a process of hands-on investigation and discovery in a laboratory setting. The central objective is to provide an active learning environment that promotes critical thinking skills, collaborative learning, and an understanding and appreciation of the process of scientific investigation. Three hours of lecture and two hours of laboratory per week.

191. General Physics. Credit 3 hours. Prerequisites: Mathematics 162, or 165, or 200, or permission of the Department Head. A study of the fundamentals of mechanics, heat and sound for students in the biological sciences, industrial technology, and other areas where a knowledge of calculus is not required.

191H. General Physics Honors. Credit 3 hours. Prerequisites: Enhanced ACT mathematics standard score of 27 or higher or completion of Mathematics 162, or 165, or 200 with a grade of C or higher; and registration for Physics Lab 193H. A study of the fundamentals of mechanics, heat and sound for students in disciplines where a knowledge of calculus is not required.

192. General Physics. Credit 3 hours. Prerequisite: Physics 191. A study of the fundamentals of electricity, magnetism, light, and modern physics for students in the biological sciences, industrial technology, and other areas where a knowledge of calculus is not required.

193. General Physics Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Physics 191. Selected laboratory experiments designed to supplement the lecture in Physics 191. Two hours of laboratory a week.

193H. General Physics Honors Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Physics 191H. Selected laboratory experiments designed to supplement the lecture in Physics 191H. Two hours of laboratory a week.

194. General Physics Laboratory. Credit 1 hour. Prerequisites: Physics Lab 193 and registration for or prior credit for PHYS 192. Selected laboratory experiments designed to supplement the lecture in Physics 192. Two hours of laboratory a week.

221. General Physics. Credit 3 hours. Prerequisites: Registration or prior credit for Mathematics 201. Basic principles of mechanics, heat and sound for technical students only.

222. General Physics. Credit 3 hours. Prerequisite: Physics 221. Basic principles of electricity, magnetism, and light for technical students only.

223. General Physics Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Physics 221. A corresponding laboratory course for Physics 221. Three hours of laboratory a week.

224. General Physics Laboratory. Credit 1 hour. Prerequisites: Physics Lab 223 and registration for or prior credit for Physics 222. A corresponding laboratory course for Physics 222. Three hours of laboratory a week.

241. Engineering Statics. Credit 3 hours. Prerequisites: Physics 221 and Physics 222 and Mathematics 201. Vectors; two-dimensional and three-dimensional force system; equilibrium; friction; centroids; mass moments of inertia; second moments of areas.

242. Engineering Circuits. Credit 3 hours. Prerequisites: Physics 221 and Physics 222 and Mathematics 201. Introduction to linear, time-invariant and jumped circuits. Kirchoff's laws, analysis of resistive circuits and steady-state and analysis of RLC and transformer circuits.

301. Electricity and Magnetism. Credit 3 hours. Prerequisite: Physics 222. Advanced study of the fundamentals of electricity and magnetism.

303. Electricity and Magnetism Laboratory. Credit 1 hour. Prerequisites: Physics Lab 224 and registration for or prior credit for Physics 301. Selected experiments in advanced electricity and magnetism. Three hours of laboratory a week.

312. Optics. Credit 3 hours. Prerequisites: Physics 222/224 and registration for or prior credit for Physics 314. Advanced study of the fundamentals of geometric and physical optics.

314. Optics Laboratory. Credit 1 hour. Prerequisite: Registration for or prior credit for Physics 312. A laboratory course designed to introduce the student to the operational techniques of advanced optical instruments. Two hours of laboratory a week.

321. Thermodynamics. Credit 3 hours. Prerequisites: Physics 222/224 and Mathematics 201. An introduction to the principles of thermodynamics, kinetic theory, and statistical mechanics.

331. Mathematical Physics. Credit 3 hours. Prerequisites: Physics 222/224 and Mathematics 201. A study of vectors, complex variables, and other selected topics that have application in mechanics, electromagnetic wave theory, and vibratory motion.

332. Intermediate Mechanics. Credit 3 hours. Prerequisite: Physics 222. A study of the fundamentals of mechanics.

335. Physics Education Laboratory. Credit 3 hours. Prerequisite: This course can only be taken by science education majors or by consent of the Department Head of Chemistry and Physics. A laboratory course designed for secondary and/or elementary school science teachers. Experiments will be presented and performed that illustrate the theories of physics and

that can be used as demonstrations. Theory will be presented and used in conjunction with experiments. Six hours of laboratory per week.

336. Physical Science Laboratory. Credit 4 hours. This course may be taken only by elementary education majors and elementary school teachers or by consent of the Department Head of Chemistry and Physics. A laboratory course designed for elementary education majors or elementary school teachers. Experiments will be presented and performed that illustrate physical theories and that can be used as demonstrations. Theory and concepts will be presented and used in conjunction with experiments. Six hours of laboratory per week.

351. Modern Physics. Credit 3 hours. Prerequisites: Physics 222/224. A survey of the modern physical theories of relativity, quantum mechanics, the solid state, molecular structure, and elementary particles.

381. Intermediate Mechanics for Science Education. Credit 3 hours. Prerequisite: Physics 222. A study of the fundamentals of mechanics. A course designed for students in Science Education. This course may not be used for a major or minor in physics. Credit may not be given for both Phys 332 and 381.

382. Electricity and Magnetism for Science Education. Credit 3 hours. Prerequisite: Physics 222. Advanced study of the fundamentals of electricity and magnetism. A course designed for students in Science Education. This course may not be used for a major or minor in physics. Credit may not be given for both Physics 382 and 301.

401/501. Advanced Mechanics. Credit 3 hours. Prerequisites: Physics 332. A continuation of Physics 332 with further study of the fundamentals of mechanics.

402/502. Electromagnetic Wave Theory. Credit 3 hours. Prerequisite: Physics 301. A theoretical treatment of electromagnetic waves.

411/511. Physics Seminar. Credit 1 hour. Prerequisite: Permission of the Department Head. Reviews and discussion of current research topics by students, faculty, and industrial personnel.

412/512. Physics Seminar. Credit 1 hour. A continuation of Physics 411/511.

421/521. Quantum Mechanics I. Credit 3 hours. Prerequisites: Physics 222/224. A course on the fundamentals of quantum mechanics.

422/522. Quantum Mechanics II. Credit 3 hours. Prerequisites: Physics 421/521. A continuation of Physics 421/521.

425. Advanced Undergraduate Laboratory. Credit 2 hours. Prerequisites: Physics 301, 303, and Physics 351. An advanced laboratory for all majors in physics. Selected experiments in modern physics will be performed with an emphasis on data acquisition and error analysis. Six hours of laboratory per week.

430/530. Special Topics in Physics. Credit 1-3 hours per semester. Prerequisite: Senior standing in physics or permission of the Department Head. A reading course with topics and credit to be decided by agreement between the Department Head and the student. This course may be repeated for a total of six credit hours if different topics are studied.

612. Laser Physics. Credit 3 hours. Prerequisite: PHYS 402 or permission of Department Head. Topics include electromagnetic fields, propagation of optical beams, optical resonators, interaction of radiation and atomic systems, laser oscillation, modulation of optical radiation and some specific laser systems. Laser interferometric gravitational wave detector may be used as an example.

619. Computational Methods in Physics. Credit 3 hours. Prerequisites: Physics 331 or Mathematics 350 or Chemistry 395. Computational methods for solving practical problems arising in physics. Topics include numerical methods for solving equations, systems of equations, ordinary differential equations, partial differential equations, polynomial integration and least square approximation.

621. Conceptual Frameworks in Introductory Physics I. Credit 3 hours. Prerequisites: Physics 221 and permission of the Department Head. This is a three credit-hour graduate course that will provide a rigorous treatment of the conceptual frameworks of introductory physics. Three major themes will guide the course: the process of science, motion as explained by force, and motion as explained by energy. The course will consist of textbook-supported guided inquiry exercises that lead students through their own development of the conceptual frameworks of physics by constructing, applying, evaluating, and/or revising theories and models in light of empirical evidence.

622. Conceptual Frameworks in Introductory Physics II. Credit 3 hours. Prerequisites: Physics 222, Physics 621, and permission of the Department Head. This is a three credit-hour graduate course that will provide a rigorous treatment of the conceptual frameworks of introductory physics. Three major themes will guide the course: the process of science, motion as explained by force, and motion as explained by energy. The course will consist of textbook-supported guided inquiry exercises that lead students through their own development of the conceptual frameworks of physics by constructing, applying, evaluating, and/or revising theories and models in light of empirical evidence.

PHYSICAL SCIENCE (PHSC)

101. Physical Science I. Credit 3 hours. A survey course in selected topics of physics designed primarily for students majoring in a non-science degree. Course consists of three hours of lecture and demonstrations per week.

102. Physical Science II. Credit 3 hours. A survey course in the cultural and applied aspects of chemistry designed primarily for students majoring in a non-science degree. Credit cannot be given for both Physical Science 102 and Chemistry 109. Course consists of three hours of lecture and demonstrations per week.

142. Elementary Physical Science. Credit 4 hours. Prerequisites: Education major, inservice teacher, or permission of the Department Head. This course is designed to prepare prospective and inservice K-12 teachers to teach physical science as a process of inquiry. The curriculum focuses on core concepts of physics and chemistry, and students will actively engage in a process of hands-on investigation and discovery in a laboratory setting. The primary objective is to provide a student-centered, active-learning environment that promotes critical thinking, collaborative learning, and an understanding and appreciation of the processes of scientific investigations. Five hours of integrated lecture and laboratory per week.

631. Computational Modeling in Physical Science. Credit 3 hours. Prerequisites: PHYS 622 or CHEM 622. A course designed to address introductory level topics in physical science with high performance computational modeling. Three major

themes will guide the course: helping students clearly understand the tools and techniques of computational science to better understand how they are used in both modern research and teaching; providing students with an opportunity to deepen their content knowledge in a manner very different than traditional education in physical science, and providing students with alternate strategies that enable them to more effectively teach conceptual topics in physical science. Numerical modeling, systems dynamics modeling, agent modeling, and molecular modeling software tools and techniques will be used for a variety of physics and chemistry topics.

635. Curriculum Design for Physical Science. Credit 3 hours. Prerequisites: PHYS 621/622 or CHEM 621/622 and PHSC 631. A graduate-level capstone course that explores the elements of research-based curriculum design and their application for physical science. The three themes of the course include: identifying the key elements of research-based curricula, investigating and evaluating the application of these elements in the existing pool of research-based curricula for physical science, and the application of these elements toward the creation of original lessons and curriculum units for physical science. Key elements that will be surveyed include how people learn, teaching for understanding, assessment and its role in "backwards design", as well as the role of content standards, inquiry, nature of science, instructional models, technology, and various pedagogical structures (i.e. cooperative learning, questioning, science talk) in curriculum design.

SCIENCE EDUCATION (SCIE)

300. Teaching Methods for Science Teachers. Credit 4 hours. Prerequisites: GBIO 151, 152, BIOL 153, 154, CHEM 121, 122, CLAB 123, 124, PHYS 191, 192 and PLAB 193, 194 (or 24 hours of equivalent courses, with 8 hours each in biology, chemistry, and physics). Eight hours of lecture/laboratory per week including a total of forty hours of participation in secondary science classroom teaching or tutoring. This capstone course is designed for teacher candidates who will be teaching science, particularly at the secondary level. Pedagogy content centers on effectively developing, delivering, and assessing science knowledge in a secondary school classroom based on national and state teaching standards. The science content is designed to reflect current issues and research in science.