Division I

Division I includes the Departments of Biology, Chemistry, Mathematics and Computer Science, and Physics.

The Faculty of Division I

Feller, Scott (chair)

Bost, Anne

Brown, James

Burton, Patrick ***

Dallinger, Gregory

Dallinger, Richard

Foote, Robert

Ingram, Amanda

Ison, Jennifer

Krause, Dennis

Madsen, Martin

McKinney, Colin

Novak, Walter

Poffald, Esteban **

Polley, L. David

Porter, Lon

Raycroft, Francis

Taylor, Ann ***

Thompson, Peter

Turner, William

Westphal, Chad

Wetzel, Eric

Wysocki, Laura

Yarnall, Carolyn

*** Sabbatical leave, full year

** Sabbatical leave, spring semester

Department of Biology

Faculty in the Department of Biology: Amanda Ingram (chair), Anne Bost, Patrick Burton ***, Jennifer Ison, L. David Polley, Francis Raycroft, and Eric Wetzel. *** *sabbatical leave, full year*

The curriculum of the Biology Department is designed to introduce the student to the breadth of the discipline of biology and to provide the foundation for further study in biology. A core sequence of courses introduces the student to genetics, cell biology, organismal biology, and ecology. The student may then choose elective courses in areas relevant to his career interests. The biology major is designed to prepare the student for graduate or professional work in biology, as well as other careers such as law or business.

We emphasize the process of biological science through course content, laboratory and field work, independent study, and summer research with faculty. The capstone course, BIO 401, introduces the student to the primary literature in biology and the skills needed to analyze critically new information in biology.

For the non-major, we offer a number of opportunities to study biology. For the student looking for a laboratory course for distribution, BIO 101 introduces the basic concepts of biology by examining the biology of humans. This course can also be used as an entry point for additional work in biology since it is a prerequisite for several courses in the department. BIO 102, 151, and irregularly offered special topics courses at the 100 level (BIO 177 or 178) are also designed for non-majors.

Requirements for the Major: Students majoring in biology must complete: (1) a core of 7 course credits; (2) 2 additional course credits in biology; (3) PHY 111; (4) CHE 111 and 221; and (5) comprehensive exam in biology.

The Biology Core Curriculum: BIO 111, 112, 211, 212, 213, 401, and one of the following: 221, 222, 224, 225, or 226.

Introductory Courses (two course credits): Students will begin their major in biology by taking BIO 111 and 112. These courses should be completed during the freshman year.

Genetics and Cell Biology (one course credit each): BIO 211 and 212 should be completed during the sophomore year.

Ecology (one course credit): BIO 213 should be completed during the first semester of either the junior or senior year.

Organismal Biology (one course credit) — one of the following courses:

BIO 221 (Comparative Anatomy and Embryology of the Vertebrates)
BIO 222 (Biology of the Invertebrates)
BIO 224 (Biology of the Vascular Plants)
BIO 225 (Microbiology)
BIO 226 (Parasitology)

This requirement must be completed after the Introductory Courses and before the beginning of the second semester of the senior year.

Senior Seminar (one course credit): Usually, BIO 401 is taken during the first semester of the senior year. Students who will be off-campus during the first semester of their senior year should take BIO 401 during the first semester of their junior year.

Supporting the Biology Curriculum: Biology majors must complete 2 additional course credits for a total of nine course credits in biology. These credits may be compiled from the following: BIO 221, 222, 224, 225, 226, 311, 313, 314, 315, 316, 351, 387, and 388. Because most of these courses (BIO 221, 222, 224, 225, 226, 311, 313, 314, 315, 316, 351) are offered in alternate years, students must carefully plan their curriculum (in consultation with a Biology Department faculty member). In some years, one or more special topics courses (BIO 371) may be offered and may be used to complete the major. Descriptions of these courses will be provided to students and advisors before advance registration.

Students interested in biological research are encouraged to undertake Independent Study (BIO 387, 388) during their junior or senior year. Well-prepared students may begin Biology Independent Study before their junior year.

Beyond the nine course credits required for the biology major, students may include two additional biology course credits to satisfy graduation requirements. Students interested in graduate school in biology are encouraged to consider this option.

Supporting the Physics, Chemistry, and Mathematics/Computer Science Curricula: PHY 111 and CHE 111 and 221 are required. Students intending to proceed to a professional or a graduate school should plan to include MAT110 or 111, PHY 112 or 113, and CHE 321 and 331 in their curriculum. Usually CHE 111 and 211 are taken during the sophomore year; PHY 111 and 112 and CHE 221 and 321 are taken during the junior year. MAT 112, CSC 111, and a statistics course (MAT 254 or DV3 252) may be important support courses for some biology majors.

Comprehensive Exam in Biology: Students must pass a two-day written comprehensive exam in biology. On the first day, students write on a series of recent papers from the primary literature, drawing upon the breadth and depth of their knowledge of biology. On the second day, they answer a series of questions on specific courses. Students must complete BIO 211, 212, 213 and their organismal biology course before the spring of their senior year.

Off-Campus Study: Students who wish to take biology courses at other institutions to be credited towards graduation should first discuss their options with their advisor and then obtain permission from the Biology department chair.

Summer Field Study: Scholarship funds are available through the Lucy B. Graves Fund as scholarships for students to study at marine biological laboratories. The Robert O. Petty Fund and the E.W. Olive Fund support interns in field biology. Interested students should talk with the department chair.

Requirements for the Minor: BIO 111, 112, and three other course credits in the department. At least one of the courses beyond BIO 111, 112 must be a course in organismal biology (BIO 221, 222, 224, 225, or 226). Students who wish to initiate a biology minor via the BIO 101 course will complete four additional courses, including an organismal course.

Secondary Licensure Program: *The Department of Education Studies offers a minor in Education Studies, and an additional licensure preparation program for students interested in becoming licensed to teach at the secondary level (middle and high school grades 5-12). With a major in this department and a minor in Education Studies, students may also choose to complete the licensure preparation program by applying in the spring of the junior year. For more information about the licensure program, students are advised to meet with faculty in the Department of Education Studies. Requirements for the minor and licensure preparation program are outlined in the Department of Education Studies section of the Academic Bulletin.*

Course Descriptions

BIO 101 Human Biology
A one-semester course offered primarily for majors in the social sciences and the humanities. This course will emphasize reproduction and development, structure/function, genetics, and evolution. The ethical implications of biological knowledge also will be considered. In the laboratory, students will investigate biological problems related to humans. Three lecture/discussions and one laboratory period weekly. A student who decides, on the basis of his experience in BIO 101, to major in biology can enroll in the appropriate semester of BIO 111, 112.
Prerequisites: None
Credits: 1

BIO 102 Plants and Human Affairs
This non-majors course will explore the interface between humankind and the plant world. Through lectures/ discussion, ancillary readings, and local field trips, students will study the impact that plants have had on the development of human culture. Some topics to be covered include plant morphology, economically important plants, plant biotechnology, and plant-derived drugs. Attention will be given to modes of inquiry in the plant sciences. BIO 102 does not count toward the laboratory science distribution requirement. Offered in the fall semester of odd-numbered years.
Prerequisite: BIO 101.
Credits: 1

BIO 111 General Biology
First semester of a two-course sequence in the concepts of biology for biology majors. This course is a prerequisite for all advanced courses in biology. BIO 111 covers biomolecules, cell biology, genetics, and evolution. Three lectures and one laboratory period weekly. Offered in the fall semester.
Prerequisites: None.
Credits: 1

BIO 112 General Biology
This is the second semester of a two-course sequence in the concepts of biology for biology majors. This course is a prerequisite for most advanced courses in biology. BIO 112 covers animal and plant structure/ function relationships and evolution and diversity. Three lectures and one laboratory period weekly. This course is offered in the spring semester.
Prerequisite: BIO 111.
Credits: 1

BIO 151 Evolution
This is a course designed to provide a basic introduction to the processes of evolutionary change and the pattern of biological diversity. Lecture/discussion will focus on the evidence for evolution, including case studies from a variety of organisms. This course is designed for students not planning to major in Biology and will not count toward the requirements for the Biology major, but it may count toward the Biology minor. This course is offered in the spring semester of even-numbered years.
Prerequisites: BIO 111 or 101.
Credits: 1

BIO 211 Genetics
This is a course designed to introduce the modern concepts of the gene. The lectures stress the theory and experimental evidence relating to transmission, molecular, and developmental genetics. The laboratory is investigative in nature. This course should be taken during the sophomore year and is offered in the fall semester.
Prerequisite: BIO 112.
Credits: 1

BIO 212 Cell Biology
The primary emphasis of this course is the structure and function of the eukaryotic cell. Lectures, readings, and discussions will cover cellular organelles, types, metabolism, interactions, and regulation of activities. The laboratory focuses on cellular structure and function through the techniques of modern cell biology. This course should be taken during the sophomore year and is offered in the spring semester.
Prerequisites: BIO 211 or 213.
Credits: 1

BIO 213 Ecology
This course is an introduction to the interrelations of plants and animals with their environment. Terrestrial and aquatic ecosystems are considered. Some weekend field trips may be included. This course is offered in the fall semester.
Prerequisites: BIO 101 or 112.
Credits: 1

BIO 221 Comparative Anatomy and Embryology of the Vertebrates
This is a course presenting a broad evolutionary theme of the vertebrates using the facts of comparative anatomy, embryology, and paleobiology. It is offered in the spring semester of odd-numbered years.
Prerequisites: BIO 101 or 112.
Credits: 1

BIO 222 Biology of the Invertebrates
This is a course designed to provide students with an introduction to the diversity of invertebrate organisms through lectures, reading and discussion of primary literature, student presentations, and laboratory work. Emphasis is placed on structure, functional morphology, physiology, ecology, and evolution. A field trip during spring break has been included in the past few years. This course is offered in the spring semester of odd-numbered years.
Prerequisites: BIO 101 or 112.
Credits: 1

BIO 224 Biology of the Vascular Plants
This course is an introduction to the science of botany. A strong emphasis will be placed on the evolutionary trends in the vascular plants, with additional coverage of developmental biology, plant breeding systems, and some of the physiological adaptations plants have evolved in the transition to life in terrestrial environments. The laboratories will be primarily observational (in the field or the lab), with a broad exposure to plant diversity and taxonomy This course is offered in the spring semester of even-numbered years.
Prerequisites: BIO 101 or 112.
Credits: 1

BIO 225 Microbiology
This course is designed to introduce the student to the lifestyles and impact of the smallest organisms known. Lecture/discussion will examine topics such as microbial cell structure and function, growth and nutrition, genetics, antibiotics and pathogenesis, and microbial diversity. The laboratory is organized around an investigative, discovery driven project.

Prerequisites: BIO 111 and 112.
Credits: 1

BIO 226 Parasitology
This is a course designed to introduce students to the major groups of animal parasites. Emphasis in lectures and discussion of primary literature is placed on general principles, including diversity, morphology, transmission biology, and the ecology and evolution of the different parasite taxa. The laboratory work includes the detailed consideration of particular parasite species as representatives of larger groups, as well as an independent research project on the parasites of a selected host species. This course is offered in the fall semester of even-numbered years.
Prerequisites: BIO 101 or 112.
Credits: 1

BIO 311 Molecular Genetics
This is a course designed to explore in detail the molecular biology of the gene. Lecture/discussion will focus on areas of current interest and will include analysis of experimental evidence which underpins our understanding of gene structure and function. The laboratory is investigative in nature and provides primary experience with recombinant DNA technology, genomics, and bioinformatics. This course is offered in the spring semester of odd-numbered years.
Prerequisite: BIO 211.
Credits: 1

BIO 313 Advanced Ecology
This course emphasizes the investigative approach to ecology including experimental design and data analysis. Lectures/discussions focus on areas of current interest in ecosystem, community, and population ecology. Several field trips and an independent investigation are required. This course is offered in the spring semester of even-numbered years.
Prerequisite: BIO 213.
Credits: 1

BIO 314 Developmental Biology
Through lectures, current readings, and discussions, this course considers the principles of development with emphasis on experimental evidence for underlying mechanisms. The laboratory work includes molecular, cellular, and supracellular approaches to the investigation of developmental questions in animals and plants. This course is offered in the spring semester of even-numbered years.
Prerequisite: BIO 211.
Credits: 1

BIO 315 Organismal Physiology
The major physiological systems (nutrition, transport, gas exchange, elimination of wastes, coordination, and defense) are considered from the adaptational perspective in this course. The emphasis is on the physiological system as it is related to the survival of vertebrates in their natural environments. The laboratory focuses on physiological techniques and methods of analysis. This course is offered fall semester of even-numbered years.
Prerequisite: BIO 212.
Credits: 1

BIO 316: Evolution of Developmental Mechanisms
Students will conduct research into embryogenesis has illuminated the molecular mechanisms of development for a select few organisms in exquisite detail. The field of Evolutionary Developmental Biology compares the developmental mechanisms of these model systems to distinct, understudied taxa. Using this comparative approach, we can infer the characteristics of the common ancestors of these organisms. In this course, we will explore how molecular, paleontological and evolutionary techniques can yield insights into animals that existed half a billion years ago. Evaluations will be based on discussion of primary literature and several short papers. Offered in the spring semester of even-numbered years.
Prerequisite: Biology 211
Credits: 1

BIO 351: The Evolution of Populations
This course will provide an in-depth examination of the population-level effects of evolutionary processes. The first half of the semester will focus on examining advances in evolutionary biology, centered around a quantitative approach to understanding the principles of population genetics. The second half of the semester will involve close reading of primary literature focused on a narrow topic in population biology. Offered in the spring semester of odd-numbered years.
Prerequisite: BIO 211
Credits: 1

BIO 371 Special Topics
These are innovative courses and special programs in library research. Descriptions of special topics courses will be posted at the time of advance registration. Students desiring a special library research project should make the appropriate arrangements with individual faculty members.
Prerequisite: Permission of instructor.
Credits: 1 or 1/2

BIO 387 Introduction to Research
Students may pursue individual research on selected problems. Although only one-half course credit is to be counted toward the nine credit major, these courses may be repeated and credit received for graduation. Students should make arrangements with individual faculty members during the semester preceding their enrollment in the course.
Prerequisite: Permission of instructor.
Credits: 1/2

BIO 388 Introduction to Research
Students may pursue individual research on selected problems. Although only one-half course credit is to be counted toward the nine credit major, these courses may be repeated and credit received for graduation. Students should make arrangements with individual faculty members during the semester preceding their enrollment in the course.
Prerequisite: Permission of instructor.
Credits: 1/2

BIO 401 Senior Seminar
This is a seminar course required of all majors. Critical reading of primary literature, oral expression, and experimental design are emphasized. Students intending to be off-campus during the first semester of their senior year should take this course during their junior year. This course is offered in the fall semester.
Credits: 1

Department of Chemistry

Faculty in the Department of Chemistry: Lon Porter (chair), Gregory Dallinger, Richard Dallinger, Scott Feller, Walter Novak, Anne Taylor ***, and Laura Wysocki. *** *Sabbatical leave, full year*

The Wabash College Chemistry Department believes in a challenging curriculum which thoroughly investigates all areas of modern chemistry and in a significant hands-on laboratory experience in which students become progressively more independent as they proceed through the curriculum. We believe that such an education will prepare chemistry majors for a variety of career outcomes, including those in research, medicine, teaching, and industry. In recent years, three-fourths of our majors have gone to graduate school in chemistry/ biochemistry or to medical school following graduation. Others have chosen to take jobs as chemists or high school teachers or to attend other professional schools (business, law, and physical therapy). We strive to provide chemistry minors and pre-medical students with the knowledge base they need to succeed in their chosen fields. We seek to involve all Wabash students in the study of chemistry through non-majors courses, CHE 101 and 102. We attempt to teach all chemistry students about the relationship between chemistry and the world around them. **Faculty Advisors:** Majors are strongly urged to select an advisor from the Chemistry Department when they declare their major.

Requirements for the Chemistry Major: The chemistry major requires completion of the following core courses (eight credits): 111, 211, 221, 321, 331, 351, 361, and 441. Students may complete the nine-course requirement by selecting among the following electives: 421, 431, 451, 452, 461, 462, 471, 487, 488. CHE 421, 452, 461, and 471 may be repeated when the topics change. No more than one-half course credit of independent study (CHE 487 or 488) may be used to construct the minimum nine-course major. CHE 101 and 102 do not count toward the major.

The following courses are also required for chemistry majors: MAT 110 or 111 and MAT 112, PHY 111 and PHY 112. The mathematics courses are best taken in the freshman year, and the physics sequence should be taken in the sophomore year, because physical chemistry (taken by all junior chemistry majors) has a two-course physics prerequisite. A student who places into MAT 010 should complete the MAT 010/110 sequence in the freshman year, and then begin CHE 111 in the sophomore year. Alternatively, students who place in MAT 010 can take MAT 010 and CHE 101 concurrently, then proceed to MAT 110 and CHE 171 (a half semester course, which complements CHE 101 to allow students to proceed to CHE 221 the next fall).

Suggested order of courses for the chemistry major:

Year	Fall Semester	Spring Semester
Freshman	CHE 111	CHE 211
	MAT 111	MAT 112
Sophomore	CHE 221	CHE 321
	PHY 111	PHY 112
Junior	CHE 351	CHE 331
		CHE 361
Senior	CHE 441	

Plus one additional elective taken in the junior or senior year

Strongly Recommended Supporting Coursework:

BIO 111 and BIO 112
More Mathematics, particularly MAT 223, MAT 224, and MAT 225
More Physics, particularly PHY 210 and PHY 310
CSC 111

Biochemistry

Requirements for the Biochemistry Major: The biochemistry major requires completion of the following core courses (seven credits): 111, 211, 221, 321, 351, 361, 461, and 462. Students complete the nine-course requirement by choosing one from CHE 331 or CHE 441 and selecting one of the following courses from the Biology Department: BIO 225, 311, 314, and approved 37X courses (this course may not be counted towards a Biology minor).

The following courses are also required for biochemistry majors: MAT 110 or 111, PHY 111 and PHY 112; BIO 111, 112, 211, and 212. The mathematics courses are best taken in the freshman year, and the physics sequence is best in the sophomore year, because physical chemistry has a two-course physics prerequisite. A student who places into MAT 010 should complete the MAT 010/110 and BIO 111/112 sequences in the freshman year, and then begin CHE 111 in the sophomore year.

There are many possible routes through the Biochemistry major; please consult with the department chair for special circumstances:

Year	Fall Semester	Spring Semester		Fall Semester	Spring Semester
Freshman	CHE 211 MAT 111	CHE 211 MAT 112		BIO 111 MAT 111	BIO 112 MAT 112
Sophomore	CHE 221 PHY 111 BIO 111	CHE 321 PHY 112 BIO 112		BIO 211 CHE 111 PHY 111	BIO 212 CHE 211 PHY 112
Junior	CHE 351	CHE 331 CHE 361		CHE 221 CHE 351 or BIO Choice	CHE 321 CHE 361
Senior	CHE 461/462 CHE or BIO Choice	CHE or BIO Choice		CHE 461/462 CHE 351 or CHE or BIO Choice	CHE or BIO Choice

OR

Year	Fall Semester	Spring Semester		Fall Semester	Spring Semester
Freshman	CHE 111 BIO 111 MAT 111	CHE 211 BIO 112 MAT 112		CHE 111 BIO 111 MAT 111	CHE 211 BIO 112 MAT 112
Sophomore	CHE 221 BIO 211 PHY 111	CHE 321 BIO 212 PHY 112		CJE 221 BIO 211	CHE 321 BIO 212
Junior	CHE 351 BIO Choice	CHE 361 CHE or BIO Choice		BIO Choice or CHE 351 PHY 111	CHE 361 PHY 112
Senior	CHE 461/462 CHE or BIO Choice	CHE or BIO Choice		CHE 461/462 CHE 351 or CHE or BIO Choice	CHE Choice and/or BIO Choice

Chemistry and Biochemistry majors who wish to transfer chemistry credits from another institution as part of their major must have prior approval of the Department Chair to do so.

The written comprehensive examination for senior majors emphasizes both knowledge of basic chemical concepts and the ability to apply these concepts to new problems. The exam includes written questions over material from courses, a laboratory practical, a literature component, and an experimental design essay

Requirements for the Chemistry Minor: The following courses are required for the chemistry minor: CHE 111, 211, and 221. The student may select any other two course credits from the departmental offerings (except CHE 101 and 102) to complete the minor, provided the prerequisites for the courses are met. No more than one-half course credit of independent study (CHE 487, 488) may be used to construct the minimum five-course minor. Chemistry minors who wish to transfer a chemistry course credit from another institution as part of their minor must have prior approval of the Department Chair to do so; no more than one course credit of transfer credit from another institution may count as part of their minor.

Requirements for Pre-Meds: Pre-medical students are required to take five courses in chemistry before the end of their junior year (when the MCAT examination is generally taken). Wabash pre-med students should take the following courses to meet the pre-med chemistry requirement, CHE 111, 211, 221, 321 and 361.

Advanced Placement: Please refer to the College Advanced Placement guidelines under Credit by Examination. Potential chemistry majors and minors who wish to claim advanced placement credit should discuss placement options with the Department Chair. If the Chair and the student decide that it is in the student's best interest to take CHE 111, the advanced placement chemistry credit must be forfeited.

ACS Certified Degree: To meet the certification requirements formulated by the American Chemical Society Committee on Professional Training (CPT) as a chemist and for adequate preparation for graduate school, additional classroom and laboratory work beyond the minimum nine-course major is required. The student should consult with the Chair of the Chemistry Department concerning ways in which the remaining requirements may be fulfilled.

***Secondary Licensure Program*:** *The Department of Education Studies offers a minor in Education Studies, and an additional licensure preparation program for students interested in becoming licensed to teach at the secondary level (middle and high school grades 5-12). With a major in this department and a minor in Education Studies, students may also choose to complete the licensure preparation program by applying in the spring of the junior year. For more information about the licensure program, students are advised to meet with faculty in the Department of Education Studies. Requirements for the minor and licensure preparation program are outlined in the Department of Education Studies section of the Academic Bulletin.*

Course Descriptions

CHE 101 Survey of Chemistry
A survey course designed for non-science concentrators, which considers the historical and philosophical developments in chemistry, as well as the application of chemical principles to physical phenomena and social issues. Topics include the development of the atomic theory of matter, atomic structure, chemical bonding, thermodynamics, the chemistry of life (organic and biochemistry), and nuclear energy. Some elementary mathematics will be used. Three lectures and one laboratory each week. Partially fulfills the College laboratory science requirement, but cannot be combined with CHE 111 to complete the laboratory science requirement. This course does not satisfy requirements for the chemistry major or minor. Only CHE 101 or CHE 111, not both, may be counted toward the total number of credits required for graduation.
Prerequisites: None.
Credits: 1

CHE 102 Topics in Chemistry
A study of topics of current interest in chemistry. Topics and prerequisites will vary and will be announced prior to registration. Does not count towards the chemistry major or minor; however, it will count towards the 11-course maximum. Does not count towards the laboratory science distribution requirement. One-half or one course credit, either or both semesters.
Prerequisites: Vary with each individual topic; watch for course announcement prior to pre-registration.
Credits: 1 or 1/2

CHE 111 General Chemistry
This is the introductory course for science concentrators. Topics include atomic theory, stoichiometry, thermo chemistry, equilibrium, gas laws, states of matter, solutions, atomic structure, and acid/base chemistry. The laboratory, which emphasizes the basic principles discussed in lecture, includes significant synthetic and analytical work. Three lectures and one laboratory each week. This course is offered in the fall semester.
Prerequisite: Freshmen must have a MAT 111 placement or higher to enroll in this course.
Credits: 1

CHE 211 Chemical Structure and Reactivity
This is the second course in chemistry for most science concentrators (chemistry majors and minors, and pre-health students). Topics include detailed considerations of chemical thermodynamics, equilibrium and electrochemistry; the molecular orbital theory of chemical bonding; and main group and transition metal chemistry. The laboratory will feature experiments in calorimetry, electrochemistry, quantitative analysis, descriptive inorganic chemistry, and a multi-week inorganic synthesis project. Three lectures and one laboratory each week. This course is offered in the spring semester.
Prerequisite: CHE 111.
Credits: 1

CHE 221 Organic Chemistry I
A study of the structure and reactions of simple organic compounds. Included as topics are molecular conformations, stereochemistry, and a discussion of some types of modern spectroscopic techniques. The laboratory work emphasizes techniques frequently used by the organic chemist, including distillation, crystallization, sublimation, chromatography, and spectroscopy. Three lectures and one laboratory each week. This course is offered in the fall semester.
Prerequisite: CHE 111.
Credits: 1

CHE 302 Electron Microscopy (PHY 302)
Electron microscopes employ a focused beam of highly energetic electrons to examine sample morphology and topography on a very fine scale. This information is essential to the characterization of a wide range of biological and inorganic specimens including microorganisms, cells, crystals, metals, microelectronics, and nanomaterials. The initial classroom portion of this course focuses on fundamental topics in instrument design, applications, limitations, and sample preparation methods. Subsequent laboratory work involves hands-on instrument training and a substantial microscopy project.
Prerequisite: Junior or senior major in chemistry/physics.
Credits: 1/2

CHE 321 Organic Chemistry II
Characteristic reactions and syntheses of organic molecules will be covered in this course. Spectroscopic techniques not covered in CHE 221 will also be surveyed. Emphasis is placed on the utility of organic chemistry in today's world; class discussions and laboratory work will present many biologically interesting illustrations. Also included is an introduction to the use of the chemical literature. Three lectures and one laboratory each week. This course is offered in the spring semester.
Prerequisite: CHE 221.
Credits: 1

CHE 331 Advanced Analytical Chemistry
An integrated survey of the application of instrumental methods (chromatography, electrochemistry, and spectroscopy) to the analysis of chemical systems. Statistical methods of data analysis will also be covered. Extensive use is made of examples taken from the current literature. The laboratory emphasizes instrumental methods of separation and analysis. Three lectures and one laboratory each week. This course is offered in the spring semester.
Prerequisite: CHE 211.
Credits: 1

CHE 351 Physical Chemistry I
An introduction to quantum mechanics through the study of exactly soluble models of chemical significance is followed by a statistical mechanical development of chemical thermodynamics. Topics include the postulates of quantum mechanics, the Schrodinger equation, the Heisenberg uncertainty principle, equations of state, partition functions, laws of thermodynamics, and the thermodynamics of ideal and non-ideal solutions. The laboratory applies concepts studied in lecture and emphasizes laboratory report writing skills. Three lectures and one laboratory each week. This course is offered in the fall semester.
Prerequisites: CHE 211, PHY 112, and MAT 112.
Credits: 1

CHE 361 Biochemistry
Basic chemical concepts such as intermolecular forces, equilibria, energetics, and reaction mechanisms will be used to study biological systems. The class will be divided into three major foci: biomolecular structures, metabolism, and information transfer. The laboratory will familiarize students with common biochemical techniques and will integrate current areas of biochemical research. Three lectures and one laboratory each week. This course is offered in the spring semester.
Prerequisites: CHE 211 or 321.
Credits: 1

CHE 421 Advanced Topics in Organic Chemistry
Topics covered vary from year to year. Examples of recent topics include advanced synthesis, medicinal chemistry, and physical organic chemistry. This course is offered either in the fall or spring semester.
Prerequisite: CHE 321.
Credits: 1/2

CHE 431 Advanced Laboratory
A laboratory-oriented presentation of various advanced concepts in chemical instrumentation. Experiments dealing with basic analog and digital electronics will stress measurement techniques and the construction and testing of simple, yet useful, circuits. The use of laboratory computers will be considered, with emphasis on data collection (interfacing) and manipulation. These topicswill be integrated into discussion and experiments dealing with instrumental analysis (electrochemistry, spectroscopy). Individual projects will involve the construction/characterization of analytical instruments. One discussion and one laboratory each week. This course is offered on an occasional basis.
Prerequisite: CHE 331.
Credits: 1/2

CHE 441 Advanced Inorganic Chemistry
A survey of the periodic table emphasizing the applications of modern structural principles, kinetics, and thermodynamics to inorganic systems. Descriptive treatment of selected elements and families included. The laboratory experiments emphasize the synthesis and characterization of air-sensitive compounds. Three lectures and one laboratory each week. This course is offered in the fall semester.
Prerequisites: CHE 211 and 351.
Credits: 1

CHE 451 Physical Chemistry II
An advanced study of quantum mechanics beyond 351, including molecular structure, group theory, molecular spectroscopy, and advanced concepts in chemical bonding. It is very important that students who are interested in attending graduate school in chemistry or biochemistry take this course. Laboratory experiments reflect topics discussed in lecture. This course is offered in the spring semester.
Prerequisite: CHE 351.
Credits: 1/2

CHE 452 Advanced Physical Chemistry
This course offers further study of special topics in physical chemistry beyond the topics covered in CHE 351 and 451. Examples of recent topics include chemical kinetics, molecular spectroscopy, computational quantum mechanics, and lasers in spectroscopy and chemistry. Laboratory experiments reflect topics discussed in lecture. This course is offered in the spring semester.
Prerequisite: CHE 451.
Credits: 1/2

CHE 461 Special Topics in Biochemistry
Topics vary from year to year. Examples of recent topics include the chemistry of cancer, determining structures of biomolecules, the RNA world, fermentation and brewing, and the mechanisms of enzyme action.
Prerequisites: Vary with each individual topic; watch for course announcement prior to pre-registration.
Credits: 1/2

CHE 462 Advanced Biochemistry
This capstone course for the biochemistry major will use primary literature to examine DNA replication, transcription, and translation on a molecular level, and will include a primary literature research project. This course is offered in the fall semester.
Prerequisite: CHE 361.
Credits: 1/2

CHE 471 Special Topics in Chemistry
Focused study of topics of current chemical interest for advanced students; topics vary from year to year and are announced prior to registration for each semester.
Prerequisites: Vary with each individual topic; watch for course announcement prior to pre-registration.
Credits: 1 or 1/2

CHE 487 Special Problems
Individual laboratory or library research projects under the supervision of individual faculty on selected problems for qualified students.
Prerequisites: Permission of instructor and department chair.
Credits: 1 or 1/2

CHE 488 Special Problems
Individual laboratory or library research projects under the supervision of individual faculty on selected problems for qualified students.
Prerequisites: Permission of instructor and department chair.
Credits: 1 or 1/2

Department of Mathematics and Computer Science

Faculty in the Department of Mathematics and Computer Science: William Turner (chair), Robert Foote, Colin McKinney, Esteban Poffald **, Peter Thompson, Chad Westphal, and Carolyn Yarnall.
***sabbatical leave, spring semester*

The Department of Mathematics and Computer Science has as its goals:

- To give all students who take mathematics courses a sense of the nature of mathematics and its place in society;
- To give our majors and minors an understanding of mathematics and computer science, their nature and uses; to prepare students to become effective users of mathematics and computer science in their careers;
- To prepare future high school teachers of mathematics;
- To give our students interested in continuing to graduate study in mathematics, statistics, or computer science an adequate preparation to succeed in that study.

Mathematics
Mathematics majors may opt for the Pure Mathematics Major, the Computational Mathematics Major, or the Financial Mathematics Major. There is a great deal of overlap among these choices, and all include the four core courses.

The Mathematics Core Courses: Calculus I (111) or Calculus I with Pre-Calculus Review (110), Calculus II (112), Linear Algebra (223), Abstract Algebra (331). Mathematics majors should complete the four core courses by the end of the sophomore year, if possible; they must be completed by the end of the junior year.

Requirements for the Pure Mathematics Major:
1) Core courses
2) Real Analysis (333) or Topology (341)
3) Electives to reach the department's nine-credit minimum

Requirements for the Computational Mathematics Major:
1) Core courses
2) CSC 111. This does not count toward the major, but it is a prerequisite for 337 and 338, and should be taken by the sophomore year, if possible.
3) Numerical Methods (337) or Topics in Computational Mathematics (338)
4) Electives to reach the department's nine-credit minimum

Requirements for the Financial Mathematics Major:
1) Core courses
2) Mathematical Finance (251), Mathematical Interest Theory (252), Probability Models I (253), Probability Models II (353), Statistical Models (254)
3) Mathematical Statistics (354) or Regression Models (355)
4) Mathematics electives to reach the department's nine-credit minimum

The requirements for the financial mathematics major are good preparation for the initial actuarial exams.

Electives may not include 010, 103, 104, 106, or 108.

Additional courses to consider, especially for students who are considering graduate school:

- Pure mathematics: 219, 221, 222, 224, 225, 323, 324, 332, 334, 344
- Computational mathematics: 219, 222, 224, 226, 314, 323, 332
- Financial mathematics: 224, 324, 333

Incoming freshmen interested in pursuing mathematics at Wabash College will typically take MAT 111 or MAT 112 in the fall (depending on placement) and MAT 112 or MAT 223 in the spring. Course choices in the fall of the sophomore year will usually depend on the direction the student sees himself headed. Students should plan to take MAT 331 in the spring of their sophomore year. Potential mathematics majors should discuss their plans with a member of the department and should read the brochure *How to Major in Mathematics at Wabash College*. Several courses are offered in alternate years; majors must plan accordingly.

Requirements for the Mathematics Minor: Five or more course credits including MAT 110 or 111, 112, 223, but excluding MAT 010, 103, 104, 106 and 108. Potential mathematics minors should read the brochure "How to Minor in Mathematics or Computer Science at Wabash College."

Secondary Licensure Program: *The Department of Education Studies offers a minor in Education Studies, and an additional licensure preparation program for students interested in becoming licensed to teach at the secondary level (middle and high school grades 5-12). With a major in this department and a minor in Education Studies, students may also choose to complete the licensure preparation program by applying in the spring of the junior year. For more information about the licensure program, students are advised to meet with faculty in the Department of Education Studies. Requirements for the minor and licensure preparation program are outlined in the Department of Education Studies section of the Academic Bulletin.*

Computer Science: No major is offered.

Requirements for the Computer Science Minor: The requirements for a minor in computer science are five courses in computer science and one course in mathematics. The computer science courses must include CSC 111 and 211, and at least a half-credit of CSC 121. The mathematics course must be MAT 108 or 219.

Potential computer science minors should consult with one of the department members who teaches computer science and should read the brochure "How to Minor in Mathematics and Computer Science at Wabash College." Computer Science minors should take CSC 111 by the end of the sophomore year.

Advanced Placement

- A student who gets a 5 on the AB calculus exam receives immediate credit for MAT 111 and is placed into MAT 112.

- A student who gets a 4 on the AB calculus exam is placed into MAT 112 without immediate credit for MAT 111.

- Any student starting in MAT 112 (by the AP exam or our internal placement) who gets a B- or better will receive retroactive credit for MAT 111.

- A student who gets a 4 or 5 on the BC calculus exam receives immediate credit for MAT 111 and 112, and is placed into MAT 223.

- A student who gets a 5 on the statistics AP exam receives immediate credit for MAT 103 and 104.

- A student who gets a 4 or 5 on the computer science AP exam receives credit for CSC 111 after taking another course beyond 111 and getting a grade of B- or better.

Course Descriptions

MAT 010 Pre-calculus with an Introduction to Calculus I
This course is intended solely for those students who wish to take calculus, but whose preparation makes a slower-paced course in calculus advisable. Topics covered include a review of algebra (solving equations and inequalities, simplification of algebraic expressions), properties of polynomials and rational functions, limits, continuity, an introduction to derivatives via polynomials and rational functions, and applications of the derivative. MAT 010 cannot be used for any distribution credit or any area of concentration. (For students who desire a distribution credit in mathematics but do not wish to take calculus, MAT 103, 104, 106, and 108 are recommended.) This course is offered in the fall semester.
Prerequisite: Permission of the instructor.
Credits: 1

MAT 103 Probability
Topics include a brief introduction to probability, conditional probability, and expected values as well as the application of probabilistic reasoning to interesting problems in the areas of medical testing, investing, insurance, retirement annuities, and the analysis of rare events. MAT 103 does not count toward the mathematics major or minor.
Prerequisites: None.
Credits: 1/2

MAT 104 Statistics
In this course, we present the classical approach to statistical reasoning, both the p-value argument to testing claims and the confidence interval approach to estimation. Other topics include correlation, prediction, and paradoxes involving averages. MAT 104 does not count toward the mathematics major or minor.
Prerequisites: None. (MAT 103 is not a prerequisite for MAT 104)
Credits: 1/2

MAT 106 Topics in Contemporary Mathematics
A reflective examination of basic mathematical ideas. Through participation and discovery, students will consider an articulation of mathematics that focuses on patterns, abstraction, and inquiry. Topics will vary, but could include logic, Euclidean geometry, algorithms, etc. This course does not count toward the major or minor in mathematics.
Prerequisites: None.
Credits: 1

MAT 108 Introduction to Discrete Structures
An introduction to discrete mathematics for students not planning to major in mathematics. Topics include sets and logic, proof methods, counting arguments, recurrence relations, graphs, and trees. This course may be used to meet the mathematics requirement for the computer science minor. However, it does not count toward the mathematics major or minor. Students may not present both MAT 108 and 219 for credit toward graduation. This course is offered in the fall semester.
Prerequisites: None.
Credits: 1

MAT 110 Calculus I with Pre-calculus Review
This course is intended solely for those students who took and passed MAT 010 and desire to complete a course in calculus. Successful completion of this course is equivalent to completion of MAT 111. Topics covered include an introduction to integration via polynomials and rational functions, applications of the integral, Fundamental Theorem of Calculus, and introduction to exponential, logarithmic and trigonometric functions, and the application of the derivative and integral to these families of functions. The focus is on understanding basic concepts and gaining basic computational skills. This course counts as a distribution

credit in mathematics. Credit cannot be given for both MAT 110 and MAT 111. This course is offered in the spring semester.
Prerequisite: MAT 010.
Credits: 1

MAT 111 Calculus I
Basic calculus of one variable from an intuitive point of view. Topics include limits, continuity, derivatives and integrals of the elementary functions, Fundamental Theorem of Calculus, and applications. The focus is on understanding basic concepts and gaining basic computational skills.
Prerequisite: None.
Credits: 1

MAT 112 Calculus II
A continuation of MAT 111. Numerical and symbolic techniques of integration, applications of integration, an introduction to partial derivatives and multiple integrals, sequences and series, and Taylor's Theorem.
Prerequisites: MAT 110 or 111, departmental placement examination, or AP examination.
Credits: 1

MAT 219 Combinatorics
This course is an introduction to combinatorial reasoning. Topics include graphs, circuits in graphs, graph coloring, trees, counting principles, generating functions, and recurrence relations. This course is offered alternate years. Next anticipated offerings will be spring semester 2014. Students may not present both MAT 108 and 219 for credit towards graduation.
Prerequisite: MAT 223.
Credits: 1

MAT 221 Foundations of Geometry
A development of Euclidean and non-Euclidean geometries from a modern viewpoint. This course is offered in the spring semester.
Prerequisite: MAT 112.
Credits: 1

MAT 222 Theory of Numbers
A study of elementary number theory. Topics include divisibility, congruences, properties of prime numbers, number theoretic functions, diophantine equations, and additional selected topics. This course is offered in the spring semester of odd-numbered years.
Prerequisite: MAT 112.
Credits: 1

MAT 223 Elementary Linear Algebra
An introduction to linear mathematics. Linear systems of equations, matrices, determinants, vector spaces, bases and dimension, function spaces, linear transformations, eigenvalues and eigenvectors, inner products, and applications. An important aspect of the course is to introduce the student to abstract thinking and proofs.
Prerequisites: MAT 112, departmental placement examination, or AP examination.
Credits: 1

MAT 224 Elementary Differential Equations
Introduction to ordinary differential equations. Special solution techniques and some theory for first-order and linear equations including integrating factors, constant coefficients, undetermined coefficients, variation of parameters, power series solutions, Laplace transforms, and systems of differential equations applications. This course is offered in the spring semester.
Prerequisites: MAT 112 and 223.
Credits: 1

MAT 225 Multivariable Calculus
Calculus in higher dimensions. Limits, continuity, differentiability, directional derivatives, constrained and unconstrained optimization, geometry of curves, multiple integrals, general coordinate systems, path and surface integrals, vector calculus, theorems of Green and Stokes applications. This course is offered in the fall semester.
Prerequisites: MAT 112 and 223.
Credits: 1

MAT 226 Operations Research
Linear and nonlinear optimization, linear programming, integer programming, duality, combinatorics, the simplex method and related algorithms, game theory, Markov chains, queuing theory. This course is offered irregularly.
Prerequisite: MAT 223.
Credits: 1

MAT 251 Mathematical Finance
The course gives an overview of the mathematical reasoning behind the pricing of options. Topics include binomial models, put-call parity, a probabilistic derivation of the Black-Scholes pricing formula for call options, and delta hedging. We will also look at Asian, gap, and barrier options. This course is offered in the fall semester.
Prerequisite: MAT 112.
Credits: 1/2

MAT 252 Mathematical Interest Theory
This course will involve a thorough treatment of the mathematical theory of interest, with special attention paid to calculating present and accumulation values for annuities (series of payments made at regular time intervals). Some topics include nominal and effective rates of interest and discount, force of interest, amortization schedules, sinking funds, and bonds. This course is offered in the fall semester.
Prerequisite: MAT 112.
Credits: 1/2

MAT 253 Probability Models
This course is an introduction to discrete and continuous random variables. Distributions considered include the hypergeometric, binomial, geometric, Poisson, uniform, normal, gamma, chi-square, t and F. We will cover the Central Limit Theorem, multivariate distributions, and transformations of random variables. This course is offered in the fall semester.
Prerequisite: MAT 112.
Credits: 1/2

MAT 254 Statistical Models
This course gives an overview of confidence intervals, classical hypothesis testing procedures: z-tests, t-tests, F-tests, Chi-square tests, basic factorial, complete block, Latin square designs, and regression. An intuitive but mathematical treatment is given for all the distributions and procedures involved. This course is offered in the spring semester.
Prerequisite: MAT 112.
Credits: 1/2

MAT 314 Modeling with Differential Equations
A course to develop the basic skills of formulation, simplification, and analysis of mathematical models for describing and predicting phenomena in the natural and social sciences, with special emphasis in modeling with differential equations. Topics may be taken from fields such as physics, chemistry, biology, psychology, economics, and political science. This course is offered alternate years. The next anticipated offering of this course will be the fall semester of 2014.
Prerequisite: MAT 224.
Credits: 1

MAT 323 Topics in Linear Algebra
An in-depth study of some of the topics covered in MAT 223, including the theory of vector spaces, linear transformations, and Euclidean spaces, together with some additional topics, which may include isomorphisms, duality, canonical forms, and applications of linear algebra. This course is offered irregularly.
Prerequisite: MAT 223.
Credits: 1

MAT 324 Topics in Differential Equations
A second course in differential equations offering study of special topics in more depth or beyond those covered in MAT 224. Topics may include existence and uniqueness theory, stability theory, Green's functions, dynamical systems, partial differential equations, and applications of differential equations. This course is offered in the fall semester of odd-numbered years.
Prerequisite: MAT 224.
Credits: 1

MAT 331 Abstract Algebra I
A first course in higher abstract mathematics. Emphasis is placed on writing proofs. Topics include groups and rings. This course is offered in the spring semester.
Prerequisite: MAT 223.
Credits: 1

MAT 332 Abstract Algebra II
A continuation of MAT 331. Topics will depend on the instructor but may include fields, modules, Galois theory, or advanced topics in groups and rings. This course is offered irregularly.
Prerequisite: MAT 331.
Credits: 1

MAT 333 Introduction to Functions of a Real Variable I
A first course in the foundations of modern analysis. Topics include set theory, topology of the real numbers, sequences, series, differentiation, integration, and rigorous proofs of the major theorems of single-variable calculus. This course is offered in the fall semester.
Prerequisite: MAT 223. It is recommended that students take MAT 331 before MAT 333.
Credits: 1

MAT 334 Introduction to Functions of a Real Variable II
A continuation of MAT 333. Topics will depend on the instructor but may include sequences and series of functions, Fourier analysis, elementary functional analysis, advanced multivariable calculus or metric spaces. This course is offered irregularly.
Prerequisite: MAT 333.
Credits: 1

MAT 337 Introduction to Numerical Analysis (CSC 337)
This course will address topics such as numerical solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. This course is offered in the fall semester of even-numbered years.
Prerequisites: CSC 111 and MAT 223.
Credits: 1

MAT 338 Topics in Computational Mathematics (CSC 338)
A course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. This course is offered in the fall semester of odd-numbered years.
Prerequisite: CSC 111 and MAT 112. Some topics may have additional prerequisites.
Credits: 1

MAT 341 Topology
A study of elementary topology. Topics discussed will include topologies, separation axioms, connectedness, compactness, continuity, and metric spaces. This course is offered in the spring semester of even-numbered years.
Prerequisite: MAT 223.
Credits: 1

MAT 344 Complex Analysis
Analytic functions, mapping of elementary functions, integrals, residue theory, conformal mapping. This course is offered in the spring semester of odd-numbered years.
Prerequisite: MAT 223.
Credits: 1

MAT 353 Probability Models II
This course is a continuation of MAT 253 (Probability Models). Topics include survival functions, hazard functions, order statistics, continuous and discrete distributions not considered in MAT 253, and mixed random variables. We will look at a wide variety of probability problems associated with insurance. This course is offered in the fall semester.
Prerequisite: MAT 253.
Credits: 1/2

MAT 354 Mathematical Statistics
This course takes a more theoretical look at estimation and hypothesis testing than MAT 254 (Statistical Models). Topics include maximum likelihood estimators (MLE's), the information inequality, asymptotic theory of MLE's, complete sufficient statistics, uniformly minimum variance unbiased estimators, likelihood ratio tests, most powerful tests, uniformly most powerful tests, and Bayesian statistics. This course is offered in the spring semester, irregularly.
Prerequisites: MAT 253 and 254.
Credits: 1/2

MAT 355 Regression Models
This course takes a matrix-based look at regression (introduced in MAT 254, Statistical Models). We focus on the probabilistic reasoning behind regression, in particular the inferences we can make using linear combinations of normal random variables. We also look briefly at some time series models. This course is offered in the spring semester.
Prerequisites: MAT 223, 253 and 254.
Credits: 1/2

MAT 377 Special Topics in Mathematics
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before advance registration for that semester. This course is offered irregularly.
Prerequisites: Specific to topic, if any.
Credits: 1 or 1/2

MAT 387 Independent Study
Directed reading and research on special topics for qualified students. May be repeated for credit. Level varies (intermediate or advanced); determined in consultation with instructor.
Prerequisites: Permission of the instructor and department chair.
Credits: 1 or 1/2

MAT 388 Independent Study
Directed reading and research on special topics for qualified students. May be repeated for credit. Level varies (intermediate or advanced); determined in consultation with instructor.
Prerequisites: Permission of the instructor and department chair.
Credits: 1 or 1/2

MAT 400 Seminar
Topics in the history and foundations of mathematics, the special emphasis varying from year to year. Every student will be expected to write a term paper. This course is offered irregularly.
Prerequisites: None.
Credits: 1/2

Computer Science Courses

CSC 101 Introduction to Computer Science
An introduction to the field of computer science as the study of algorithmic process. Students will study the history of the field as well as issues currently confronting the computer science community including ethical issues raised by a rapidly changing technology. Students will learn fundamental concepts of computer science such as computer architecture, data representation, and the issues of computability. Students will engage in hands-on algorithm-building activities and some basic programming exercises. This course is offered in the fall semester. *Distribution in Natural Science and Mathematics or Quantitative Skills.*
Prerequisites: None.
Credits: 1

CSC 111 Introduction to Programming
An introduction to programming in a higher-level, general-purpose language (currently Java). Programming topics include primitive data types, simple data types such as arrays, program constructs such as conditionals, loops and procedures, in an object-oriented context. Applications are chosen from areas such as graphics, simulation, and file processing. This course is offered in the spring semester. *Distribution in Natural Science and Mathematics or Quantitative skills.* (Note: CSC 111 does not count as a laboratory science.)
Prerequisite: CSC 101 (With appropriate background and instructor permission, a student may possibly take CSC 111 without having taken CSC 101 first).
Credits: 1

CSC 112 Advanced Programming
A variety of topics that are important in developing large-scale software. Object oriented programming in a language such as C++. Dynamic data structures such as lists, queues, and stacks. An introduction to a rigorous analysis of the efficiency of an algorithm. Advanced algorithms such as Quicksort, mergesort, and the use of hash tables. An introduction to using the Unix operating system and Unix tools for software development such as Make. This course is offered in the semester.
Prerequisites: CSC 111 or equivalent programming background.
Credits: 1

CSC 121 Introduction to Additional Programming Languages
An introduction to one or more additional programming languages. Students will build on their previous knowledge of a programming language to learn one or more additional languages. Languages vary by semester but may include any programming paradigm. For a given semester the course content and other particulars will be announced before registration for that semester. This course may be taken multiple times, for credit for each different language.
Prerequisite: CSC 111
Credits: 1/2

CSC 211 Introduction to Data Structure
An introduction to more advanced abstract data types such as lists; sets; trees, including balanced trees; and graphs. Algorithms for traversing, searching, determining connectivity, and so forth. An in-depth study of, and analysis of, the algorithms used to implement these structures. This course is offered in the spring semester.
Prerequisite: CSC 111.
Credits: 1

CSC 271 Special Topics in Computer Science
This course is designed for the treatment of material outside the regular offerings of the department. For a given semester, the course content and other particulars will be announced before registration for that semester. This course is offered irregularly.
Prerequisites: Specific to topic, if any.
Credits: 1/2

CSC 311 Introduction to Machine Organization
A study of the various layers at which a machine can be studied, including higher-level languages, assembly language, machine language, and digital circuits. Data representation. A comparison of RISC and CISC architectures. Some programming in a representative assembly language. Issues of cross-language programming. This course is offered irregularly.
Prerequisite: CSC 211 or concurrent enrollment.
Credits: 1

CSC 321 Programming Languages
A study of the paradigms of programming languages, including procedural languages such as Pascal or 'C', object-oriented languages such as C++ or Smalltalk, functional languages such as ML or Scheme, logic-oriented languages such as Prolog, and concurrency such as in Ada. Consideration of how concepts are implemented, such as modules, parameter passing, function evaluation, data types and type checking, memory management, exception handling, and threads. This course is offered irregularly.
Prerequisite: CSC 121.
Credits: 1

CSC 331 Analysis of Algorithms
Advanced topics and problems in analyzing algorithms. Algorithms involving structures such as sequences, sets, and graphs, and topics such as geometric and numeric algorithms. An introduction to the question of P=NP and NP-Complete problems. Parallel algorithms. This course is offered irregularly.
Prerequisites: CSC 211 and MAT 108 or 219.
Credits: 1

CSC 337 Introduction to Numerical Analysis (MAT 337)
Advanced—This course will address topics such as numerical solution of non-linear equations in one variable, interpolation, approximation, differentiation, integration, difference equations, differential equations and their applications, boundary value problems, linear systems, matrices, and optimization. This course is offered in the fall semester of even-numbered years.
Prerequisites: CSC 111 and MAT 223.
Credits: 1

CSC 338 Topics in Computational Mathematics (MAT 338)
Advanced. A course to develop mathematical and computational techniques in areas of mathematics or interdisciplinary study in which computation plays a central and essential role. Topics vary by semester but may include computational geometry, computer algebra, scientific computing, and symbolic computation. This course is offered in the fall semesters of odd-numbered years.
Prerequisites: CSC 111 and MAT 112. Some topics may have additional prerequisites.
Credits: 1

CSC 341 Introduction to Automata, Computability, and Formal Languages
An introduction to theoretical computer science. Finite state machines and regular expressions. Context-free languages and push-down automata. Turing machines, effective computability, and the Halting Problem. This course is offered irregularly.
Prerequisites: CSC 111 and MAT 108 or 219.
Credits: 1

CSC 387 Independent Study
Directed study on special topics for qualified students. May be repeated for credit.
Prerequisites: Permission of the instructor and department chair.
Credits: 1/2

CSC 388 Independent Study
Directed study on special topics for qualified students. May be repeated for credit.
Prerequisites: Permission of the instructor and department chair.
Credits: 1/2

Department of Physics

Faculty in the Department of Physics: James Brown (chair), Dennis Krause, Martin Madsen

Physics is the study of the fundamental laws that govern our universe. Our curriculum is designed to give our students a solid foundation for understanding these laws and how they were uncovered. The language that best expresses these laws is mathematical, so there are a significant number of mathematics courses which serve as prerequisites for our courses. However, since physics describes the real world, our curriculum also incorporates a significant laboratory component to ensure our students will learn how to interrogate Nature and understand the answers it gives. Only by balancing theoretical concepts with experimental reality can one reach a more complete understanding of the world.

Our physics majors and minors will master valuable analysis and problem-solving skills, which can be applied to a wide variety of situations beyond physics. By integrating these skills with their liberal arts experiences, our students are prepared for a vast spectrum of careers. Recent graduates have gone on to work in physics research, engineering, computer programming, teaching, environmental studies, law, business, and other fields.

For Senior Comprehensives: Majors must pass an exam which requires them to demonstrate a coherent understanding of all the major areas of physics covered in the required courses, including computational and laboratory methods, and the ability to apply this understanding to solve specific problems.

Requirements for a Major: Nine course credits in physics. These must include PHY 111, 112, 209, 210, 381, and 382. Of the four remaining physics course credits, two must come from the following set of advanced courses: PHY 310, 314, and 315. PHY 101, 104, and 105 do not count toward the major unless supplemented by additional work that must receive prior approval by the course instructor and the physics department chair. Students accepted into a 3-2 engineering program may substitute CHE 111 for the one elective physics course. Those planning to go on to graduate school in physics should plan to take PHY 230, 310, 314, and 315. In addition, mathematics courses that are prerequisites or co-requisites for physics courses are MAT 111 (or 110), 112, 223, 224, and 225. Although not required, CSC 111 is highly recommended, and MAT 324 and 344 are useful. Since physics is a hierarchical subject, it is important to take PHY 111 and 112 during the freshman year if one wishes to major in physics. A possible schedule to fulfill all of the necessary requirements:

	Fall Semester	**Spring Semester**
Freshman	PHY 111	PHY 112
	MAT 111	MAT 112
Sophomore	PHY 209	PHY 210
	MAT 223	MAT 224
Junior	PHY elective	PHY elective
	PHY 381	PHY 382
	MAT 225	
Senior	PHY elective	PHY elective

Elective courses regularly offered in the fall semester include PHY 220/230 (alternate years), PHY 310, and PHY 315, while regularly taught spring semester courses include PHY 314. In addition, Special Topics Courses 277 or 377 may be offered in the fall, and 278 or 378 in the spring, depending on student interest and instructor availability.

Requirements for a Minor: Five courses in physics, one of which must include PHY 210 with appropriate prerequisites. Any exceptions must receive prior approval from the department chair. PHY 101, 104, and 105 do not count toward the minor unless supplemented by additional work that must receive prior approval by the course instructor and the physics department chair. Mathematics prerequisites (or co-requisites) are MAT 111 (or 110) and 112.

Secondary Licensure Program: *The Department of Education Studies offers a minor in Education Studies, and an additional licensure preparation program for students interested in becoming licensed to teach at the secondary level (middle and high school grades 5-12). With a major in this department and a minor in Education Studies, students may also choose to complete the licensure preparation program by applying in the spring of the junior year. For more information about the licensure program, students are advised to meet with faculty in the Department of Education Studies. Requirements for the minor and licensure preparation program are outlined in the Department of Education Studies section of the Academic Bulletin.*

Course Descriptions

PHY 101 Astronomy: Fundamentals and Frontiers
An introductory course intended for the non-science liberal arts student. Historical and philosophical ideas will be stressed as well as the experimental concepts and methods used in astronomy. A good working knowledge of algebra, plane geometry, and trigonometry is required. Satisfies half of the laboratory science requirement. Three class periods and one laboratory each week.
Prerequisites: None.
Credits: 1

PHY 104 Special Topics
A special interest course for the non-science liberal arts student on an introductory-level physics topic not covered in a regular physics course. (Does not count toward the major or minor, or the lab science requirement.)
Prerequisites: Determined by the topic.
Credits: 1 or 1/2

PHY 105 Adventures in Physics
A one-semester course for the non-science liberal arts student that investigates the world from the viewpoint of a physicist. Topics will vary and will be announced prior to registration. Partially fulfills the college laboratory science requirement, but does not count toward a physics major or minor. Three class periods and one laboratory each week.
Prerequisites: None.
Credits: 1

PHY 111 General Physics I
An introduction to classical mechanics for physics and other science majors. Topics include Newton's laws of motion, conservation laws, and rotational dynamics. The lab will introduce data acquisition and analysis techniques. Three class periods and one laboratory each week. This course is offered in the fall semester.
Prerequisites: MAT 111 or 110 (or concurrent registration).
Credits: 1

PHY 112 General Physics II
An introduction to the fundamental concepts concerning fluids, waves, optics, electricity, and magnetism. Three class periods and one laboratory each week. This course is offered in the spring semester.
Prerequisite: PHY 111.
Credits: 1

PHY 177 Special Topics
A special interest course on an introductory-level physics topic not covered in regular physics courses. This course is offered in the fall semester.
Prerequisites: Determined by the topic.
Credits: 1 or 1/2

PHY 178 Special Topics
A special interest course on an introductory-level physics topic not covered in regular physics courses. This course is offered in the spring semester.
Prerequisites: Determined by the topic.
Credits: 1 or 1/2

PHY 209 General Physics III
An introduction to thermal physics and special relativity. Topics include the laws of thermodynamics, statistical nature of entropy, Lorentz transformations, equivalence of mass and energy. The lab will introduce the methodology of experimental design, numerical techniques for solving differential equations, and the writing of scientific papers using LaTeX software. Three class periods and one laboratory each week. This course is offered in the fall semester.
Prerequisites: PHY 112 and MAT 112 (or concurrent registration).
Credits: 1

PHY 210 Modern Physics
An introduction to quantum theory with applications to atomic, solid state, nuclear, and particle physics. Three class periods and one laboratory each week. This course is offered in the spring semester.
Prerequisites: PHY 112 and MAT 223 (or concurrent registration).
Credits: 1

PHY 220 Electronics
Introduction to analog and digital electronics. Fundamentals of DC and AC circuits, transistors, and amplifiers will be covered. Includes one laboratory each week. This course is offered in the fall semester of even-numbered years.
Prerequisite: PHY 112.
Credits: 1

PHY 230 Thermal Physics
Introduction to thermal and statistical physics. The laws of thermodynamics are studied from microscopic and macroscopic perspectives. Quantum statistical mechanics will be developed and applied to blackbody radiation, fermionic and bosonic systems. This course is offered in the fall semester of odd-numbered years.
Prerequisites: PHY 209 and 210.
Credits: 1

PHY 277 Special Topics
A special interest course covering at an intermediate-level a physics topic not covered in regular physics courses. This course is offered in the fall semester. Student input as to the course topic will be sought prior to fall registration.
Prerequisites: Determined by the topic.
Credits: 1 or 1/2

PHY 278 Special Topics
A special interest course covering at an intermediate-level a physics topic not covered in regular physics courses. This course is offered in the spring semester. Student input as to the course topic will be sought prior to spring registration.
Prerequisites: Determined by the topic.
Credits: 1 or 1/2

PHY 287 Independent Study
This course is offered in the fall semester.
Prerequisite: Permission of instructor and department chair.
Credits: 1 or 1/2

PHY 288 Independent Study
This course is offered in the spring semester.
Prerequisite: Permission of instructor and department chair.
Credits: 1 or 1/2

PHY 302 Electron Microscopy (CHE 302)
Electron microscopes employ a focused beam of highly energetic electrons to examine sample morphology and topography on a very fine scale. This information is essential to the characterization of a wide range of biological and inorganic specimens including microorganisms, cells, crystals, metals, microelectronics, and nanomaterials. The initial classroom portion of this course focuses on fundamental topics in instrument design, applications, limitations, and sample preparation methods. Subsequent laboratory work involves hands-on instrument training and a substantial microscopy project.
Prerequisite: Junior or senior major in physics/chemistry.
Credits: 1/2

PHY 310 Classical Mechanics
Advanced topics in classical mechanics, including harmonic motion and Lagrangian mechanics. This course is offered in the fall semester.
Prerequisites: PHY 111 and MAT 224.
Credits: 1

PHY 314 Electrodynamics
Advanced explorations in understanding and applying Maxwell's equations. This course is offered in the spring semester.
Prerequisites: PHY 112 and MAT 224 and 225.
Credits: 1

PHY 315 Quantum Mechanics
Introduction to quantum mechanics. Topics include Dirac notation, postulates of quantum mechanics, and applications to important physical systems. This course is offered in the fall semester.
Prerequisites: PHY 210 and MAT 223 and 224.
Credits: 1

PHY 377 Advanced Special Topics in Physics
Special interest course covering one of a selection of advanced physics topics including: atomic physics, nuclear physics, quantum field theory, advanced electrodynamics, advanced quantum mechanics, advanced classical mechanics, or other topics proposed by students. This course is offered in the fall semester. Student input as to the course topic will be sought prior to fall registration.
Prerequisite: PHY 210.
Credits: 1 or 1/2

PHY 378 Advanced Special Topics in Physics
Special interest course covering one of a selection of advanced physics topics including: atomic physics, nuclear physics, quantum field theory, advanced electrodynamics, advanced quantum mechanics, advanced classical mechanics, or other topics proposed by students. This course is offered in the spring semester. Student input as to the course topic will be sought prior to spring registration.
Prerequisite: PHY 210.
Credits: 1 or 1/2

PHY 381 Advanced Laboratory
Students will participate in a broad range of experiments that cover major research areas in contemporary physics, including atomic, molecular, and optical physics, condensed matter physics, and nuclear and particle physics. Advanced measurement and data analysis techniques will be used. All experiments will be planned, executed, and presented according to current professional standards. This course is offered in the fall semester.
Prerequisite: PHY 210.
Credits: 1/2

PHY 382 Advanced Laboratory
A continuation of PHY 381. This course is offered in the spring semester.
Prerequisite: PHY 381.
Credits: 1/2

PHY 387 Advanced Independent Study
This course is offered in the fall semester.
Prerequisite: Permission of instructor and the department chair.
Credits: 1 or 1/2

PHY 388 Advanced Independent Study
This course is offered in the spring semester.
Prerequisite: Permission of instructor and the department chair.
Credits: 1 or 1/2