

DIVISION I

This division includes the Departments of Biology, Chemistry, Mathematics and Computer Science, and Physics.

Faculty 2011-2012

Polley, L.D (chair)

Bost, A.

Brown, J.

Burton, P.

Dallinger, R.

Feller, S.***

Foote, R.

Hoopes, M.

Ingram, A.

Kinnaman, L.

Krause, D.***

Limmer, D.

Madsen, M.

McColgin, M.

McKinney, C.

Novak, W.

Poffald, E.

Porter, L.

Ransom, T.

Sparks-Thissen, R.

Taylor, A.

Thompson, P.**

Turner, W.

Westphal, C.***

Wetzel, E.

Wysocki, L.

**Sabbatical leave, fall semester*

***Sabbatical leave, spring semester*

****Sabbatical leave, full year*

Leave, fall semester

Leave, spring semester

Leave, full year

+ Administrative leave, fall

++ Administrative leave, spring

+++ Administrative leave, full year

^ Administrative appointment, fall

^^ Administrative appointment, spring

^^^ Administrative appointment, full year

~ Part-time

DEPARTMENT OF BIOLOGY

Faculty: E. Wetzel (chair), A. Bost, P. Burton, M. McColgin, A. Ingram, L.D. Polley, T. Ransom, R. Sparks-Thissen

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, Biology 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, Biology 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.

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) Physics 111; (4) Chemistry 111 and 221; and (5) comprehensive exam in biology.

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

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

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

Ecology (one course credit): Biology 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:

- Biology 221 (Comparative Anatomy and Embryology of the Vertebrates)
- Biology 222 (Biology of the Invertebrates)
- Biology 224 (Biology of the Vascular Plants)
- Biology 225 (Microbiology)
- Biology 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, Biology 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 Biology 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: Biology 151, 221, 222, 224, 225, 226, 311, 313, 314, 315, 387, 388. Because some of these courses (Biology 221, 222, 224, 225, 226, 311, 313, 314, 315) 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 (Biology 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 (Biology 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: Physics 111 and Chemistry 111 and 221 are required. Students intending to proceed either to a professional or a graduate school should plan to include Mathematics 110 or 111, Physics 112 or 113, and Chemistry 321 and 331 in their curriculum. Usually Chemistry 111, 211, and 331 are taken during the sophomore year; Physics 111 and 112 or 113 and Chemistry 221 and 321 are taken during the junior year. Mathematics 112, Computer Science 111, and a statistics course (Mathematics 217 or Division III 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 Biology 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: Biology 111, 112, and three other course credits in the department. At least one of the courses beyond Biology 111, 112 must be a course in organismal biology (Biology 221, 222, 224, 225, 226). Students who wish to initiate a biology minor via the Biology 101 course will complete four additional courses.

An Area of Concentration in Education and Middle and High School Teaching licensure (grades 5-12) with this major is administered through the Teacher Education Program. For Education AOC and teaching licensure information, please see the *Teacher Education* section of the Academic Bulletin. Students are asked to consult with their academic advisor AND the Director of Teacher Education to learn more about course and licensure requirements.

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 Biology 101, to major in biology can enroll in the appropriate semester of Biology 111, 112. One course credit each semester.

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 www.exercises and demonstrations, students will study the impact that plants have had on the development of human culture. Some topics to be covered include the plant body, photosynthesis, economically important plants, plant genetics and biotechnology, flowers and plants in the environment. Attention will be given to modes of inquiry in the plant sciences. Several field trips are planned. This course is offered alternate years. Next anticipated offerings will be fall semesters of 2011 and 2013.

Prerequisite: Biology 101. Does not count toward the laboratory science distribution requirement.

Credits: 1

BIO 111 General Biology

A year course in the concepts of biology for biology majors. This course is a prerequisite for all advanced courses in biology. Biology 111 covers biomolecules, cell biology, genetics, and evolution. Biology 112 covers animal and plant structure/functions, evolution, and ecology. Three lectures and one laboratory period weekly. One course credit, fall semester.

Credits: 1

BIO 112 General Biology

A year course in the concepts of biology for biology majors. This course is a prerequisite for all advanced courses in biology. Biology 111 covers biomolecules, cell biology, genetics, and evolution. Biology 112 covers animal and plant structure/functions, evolution and ecology. Three lectures and one laboratory period weekly. This course is offered in the spring semester.

Prerequisite: Biology 111.

Credits: 1

BIO 151 Evolution

A general study of evolution. Lecture/discussion focuses on the processes of evolutionary change and the origin of life. Current topics in evolutionary biology and human evolution are considered. This course is typically offered in the spring semester.

Prerequisite: Biology 111 or 101.

Credits: 1

BIO 211 Genetics

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. Offered in the fall semester.

Prerequisite: Biology 112 or permission of the instructor. (This course should be taken during the sophomore year.)

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. Offered in the spring semester.

Prerequisite: Biology 211 or 213 or permission of the instructor. (This course should be taken during the sophomore year.)

Credits: 1

BIO 213 Ecology

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. Offered in the fall semester.

Prerequisite: Biology 112, or 101 and permission of the instructor.

Credits: 1

BIO 221 Comparative Anatomy and Embryology of the Vertebrates

A course presenting a broad evolutionary theme of the vertebrates using the facts of comparative anatomy, embryology, and paleobiology. This course will be offered in alternate years beginning in the spring semester of 2013.

Prerequisite: Biology 101 or 112.

Credits: 1

BIO 222 Biology of the Invertebrates

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 alternate years. Next anticipated offering is the spring semester of 2013.

Prerequisite: Biology 101 or 112.

Credits: 1

BIO 224 Biology of the Vascular Plants

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 plant biotechnology, developmental biology, and some of the physiological adaptations plants have evolved in the transition to life in terrestrial environments. The laboratories will be primarily observational, with a broad exposure to plant diversity and taxonomy; substantial field work is planned. This course is offered alternate years. Next anticipated offerings will be spring semesters of 2012 and 2014.

Prerequisite: Biology 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. This course will be offered in alternate years in the fall semester beginning in 2011.

Prerequisite: Biology 111 and 112 or permission of instructor.

Credits: 1

BIO 226 Parasitology

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 de-

tailed 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 alternate years. Next anticipated offering is the fall semester of 2012.

Prerequisite: Biology 101 or Biology 112 or permission of instructor.

Credits: 1

BIO 311 Molecular Genetics

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 alternate years. Next anticipated offering will be the spring semester of 2013.

Prerequisite: Biology 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 alternate years. Next anticipated offerings will be spring semesters of 2012 and 2014.

Prerequisite: Biology 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 alternate years. Next anticipated offerings will be spring semesters of 2012 and 2014.

Prerequisite: Biology 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. 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.

Prerequisite: Biology 212 or permission of the instructor.

Credits: 1

BIO 371 Special Topics

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

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.

Permission of instructor required.

Credits: 1/2

BIO 388 Introduction to Research

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.

Permission of instructor required.

Credits: 1/2

BIO 401 Senior Seminar

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: A. Taylor (chair), R. Dallinger, S. Feller***, M. Hoopes, W. Novak, L. Porter, L. 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 investigative 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 directly to graduate school in chemistry/ biochemistry or to medical school immediately following graduation. Others have chosen to take jobs as chemists 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, Chemistry 101 and 102. We attempt to teach all chemistry students about the relationship between chemistry and the world around them.

Requirements for the Chemistry Major: A 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. Chemistry 421, 452, 461, and 471 may be repeated when the topics change. No more than one-half course credit of independent study (Chemistry 487 or 488) may be used to construct the minimum nine-course major. Chemistry 101 and 102 do not count toward the major.

The following courses are also required for chemistry majors: Mathematics 110 or 111 and 112, Physics 111 and Physics 112 (Chemistry/Physics double majors and Physics minors will take Physics 111, 113, and 114). 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 Mathematics 010 should complete the Mathematics 010/110 sequence in the freshman year, and then begin Chemistry 111 in the sophomore year.

Suggested order of courses for the chemistry major:

Year	Fall Semester	Spring Semester
Freshman	Che 111 Math 111	Che 211 Math 112
Sophomore	Che 221 Physics 111	Che 321 Physics 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:

Biology 111, 112
More Mathematics, particularly 223, 224, 225
More Physics, particularly 210 and 310
Computer Science 111

Biochemistry

Requirements for the Biochemistry Major: A 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: Mathematics 110 or 111, Physics 111 and Physics 112; Bio 111, 112, 211, 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 Mathematics 010 should complete the Mathematics 010/110 and Bio 111/112 sequences in the freshman year, and then begin Chemistry 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 111 Math 111	Che 211 Math 112	Bio 111 Math 111	Bio 112 Math 112
Sophomore	Che 221 Physics 111 Bio 111	Che 321 Physics 112 Bio 112	Bio 211 Che 111 Physics 111	Bio 212 Che 211 Physics 112
Junior	Che 351 Bio 211	Che 361 Bio 212	Che 221 Che 351 or Bio choice	Che 321 Che 361
Senior	Che 461/462 Che or Bio choice	Che choice or Bio choice	Che 461/462 Che 351 or Che or Bio choice	Che choice or Bio choice

OR

Year	Fall Semester	Spring Semester	Fall Semester	Spring Semester
Freshman	Che 111 Bio 111 Math 111	Che 211 Bio 112 Math 112	Che 111 Bio 111 Math 111	Che 211 Bio 112 Math 112
Sophomore	Che 221 Bio 211 Physics 111	Che 321 Bio 212 Physics 112	Che 221 Bio 211	Che 321 Bio 212
Junior	Che 351 Bio choice	Che 361 Che or Bio choice	Bio choice or Che 351 Physics 111	Che 361 Physics 112
Senior	Che 461/462 Che choice or Bio choice	Che or Bio choice	Che 461/462 Che 351 or Bio choice or Che 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. One part of the exam involves reading and answering questions over several articles from the recent chemical literature; the second part of the exam involves answering questions from the core chemistry courses the student has taken. There is also a literature-based project and a laboratory practical.

Requirements for the Chemistry Minor: The following courses are required for the chemistry minor: Chemistry 111, 211, and 221. The student may select any other 2 course credits from the departmental offerings (except Chemistry 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 (Chemistry 487, 488) may be used to construct the minimum five-course minor.

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

Requirements for Pre-meds: Pre-medical students are required to take four 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, Chemistry 111, 211, 221, and 321.

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 Chemistry 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.

An Area of Concentration in Education and Middle and High School Teaching licensure (grades 5-12) with this major is administered through the Teacher Education Program. For Education AOC and teaching licensure information, please see the *Teacher Education* section of the Bulletin. Students are asked to consult with their academic advisor AND the Director of Teacher Education to learn more about course and licensure requirements.

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.

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, students are advised that 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.

Credits: 1 or 1/2

CHE 111 General Chemistry

The introductory course for science concentrators. Topics include atomic theory, stoichiometry, thermochemistry, equilibrium, gas laws, states of matter, solutions, atomic structure, and acid/base chemistry. The labora-

tory, 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 Mathematics 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: Chemistry 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: Chemistry 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 or permission of the instructor.

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 Chemistry 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: Chemistry 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: Chemistry 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: Chemistry 211, Physics 112 or 113, Mathematics 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: Chemistry 321, 211, or with permission of the instructor.

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 may be offered in either semester.

Prerequisite: Chemistry 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 topics are then 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 in the fall semester.

Prerequisite: Chemistry 331 or permission of instructor.

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: Chemistry 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: Chemistry 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 Chemistry 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: Chemistry 451 or permission of instructor.

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. This course is offered either semester.

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: Chemistry 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. Offered either or both semesters.

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. Students must have prior consent of faculty member to enroll in this course. Offered either or both semesters.

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. Students must have prior consent of faculty member to enroll in this course. Offered either or both semesters.

Credits: 1 or 1/2

DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE

Faculty: R. Foote (chair), D. Limmer, C. McKinney, E. Poffald, P. Thompson*, W. Turner, C. Westphal***

* *Sabbatical leave, fall semester*

*** *Sabbatical leave, full year*

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) Computer Science 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 Mathematics 111 or Mathematics 112 in the fall (depending on placement) and Mathematics 112 or Mathematics 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 Mathematics 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.

An Area of Concentration in Education and Middle and High School Teaching licensure (grades 5-12) with this major is administered through the Teacher Education Program. For Education AOC and teaching licensure information, please see the *Teacher Education* section of the Academic Bulletin. Students are asked to consult with their academic advisor AND the Director of Teacher Education to learn more about course and licensure requirements.

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

Computer Science: No major is offered.

Requirements for the 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 be Computer Science 111 and 112 and three other Computer Science courses. The mathematics course must be Mathematics 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 Computer Science 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 Mathematics 111 and is placed into Mathematics 112.
- A student who gets a 4 on the AB calculus exam is placed into Mathematics 112 without immediate credit for Mathematics 111.
- Any student starting in Mathematics 112 (by the AP exam or our internal placement) who gets a B- or better will receive retroactive credit for Mathematics 111.
- A student who gets a 4 or 5 on the BC calculus exam receives immediate credit for Mathematics 111 and 112, and is placed into Mathematics 223.
- A student who gets a 5 on the statistics AP exam receives immediate credit for Mathematics 103 and 104.
- A student who gets a 4 or 5 on the computer science AP exam receives credit for Computer Science 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. Mathematics 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, Mathematics 103, 104, 106, and 108 are recommended.) This course is offered fall semester.

Prerequisite: Admission by instructor permission only.

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. Mathematics 103 does not count toward the mathematics major or minor. This course is normally offered every semester; however, during the 2011-12 academic year, this course will not be offered in the fall. Spring semester offering is contingent on staffing.

Prerequisite: 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. Mathematics 104 does not count toward the mathematics major or minor. This course is normally offered every semester; however, during the 2011-12 academic year, this course will not be offered in the fall. Spring semester offering is contingent on staffing.

Prerequisite: None (Mathematics 103 is not a prerequisite for Mathematics 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. This course is normally offered in the spring semester; however, during the 2011-12 academic year, this course will be offered in the fall. Spring semester offering is contingent on staffing.

Prerequisite: 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 mathematics 108 and 219 for credit toward graduation. This course is offered in the fall semester.

Prerequisite: None

Credits: 1

MAT 110 Calculus I with Pre-calculus Review

This course is intended solely for those students who took and passed Mathematics 010 and desire to complete a course in calculus. Successful completion of this course is equivalent to completion of Mathematics 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 Mathematics 110 and Mathematics 111. This course is offered in the spring semester.

Prerequisite: Mathematics 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. This course is offered every semester.

Prerequisite: departmental placement examination.

Credits: 1

MAT 112 Calculus II

A continuation of Mathematics 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. This course is offered every semester.

Prerequisite: Mathematics 110 or 111, departmental placement examination, AP examination, or permission of the department.

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 semesters of 2012 and 2014. Students may not present both Mathematics 108 and Mathematics 219 for credit towards graduation.

Prerequisite: Mathematics 223 or permission of the instructor.

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: Mathematics 112 or permission of the instructor.

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 alternate years. Next anticipated offerings will be spring semesters of 2013 and 2015.

Prerequisite: Mathematics 112 or permission of the instructor.

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. This course is offered every semester.

Prerequisites: Mathematics 112, departmental placement examination, AP examination, or permission of the department.

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: Mathematics 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: Mathematics 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: Mathematics 223 or permission of the instructor.

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: Mathematics 112 (Calculus II)

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: Mathematics 112 (Calculus II)

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: Mathematics 112 (Calculus II)

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 normally offered in the spring semester; however, during the 2011-12 academic year, this course will be offered in the fall and not the spring.

Prerequisite: Mathematics 112 (Calculus II)

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. Next anticipated offerings will be fall semesters of 2012 and 2014.

Prerequisite: Mathematics 224.

Credits: 1

MAT 323 Topics in Linear Algebra

An in-depth study of some of the topics covered in Mathematics 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: Mathematics 223 or permission of the instructor.

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 Mathematics 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 alternate years. Next anticipated offerings will be fall semesters of 2011 and 2013.

Prerequisite: Mathematics 224 or permission of the instructor.

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: Mathematics 223 or permission of the instructor.

Credits: 1

MAT 332 Abstract Algebra II

A continuation of Mathematics 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: Mathematics 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: Mathematics 223. It is recommended that students take Mathematics 331 before Mathematics 333.

Credits: 1

MAT 334 Introduction to Functions of a Real Variable II

A continuation of Mathematics 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: Mathematics 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 alternate years. Next anticipated offerings will be fall semesters of 2012 and 2014.

Prerequisite: Computer Science 111 (or permission of the instructor) and Mathematics 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 alternate years. Next anticipated offerings will be fall semesters of 2011 and 2013.

Prerequisite: Computer Science 111. 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 alternate years. Next anticipated offerings will be spring semesters of 2012 and 2014.

Prerequisite: Mathematics 223 or permission of the instructor.

Credits: 1

MAT 344 Complex Analysis

Analytic functions, mapping of elementary functions, integrals, residue theory, conformal mapping. This course is offered alternate years. Next anticipated offerings will be spring semesters of 2013 and 2015.

Prerequisite: Mathematics 223 or permission of the instructor.

Credits: 1

MAT 353 Probability Models II

This course is a continuation of Mathematics 253 (Probability Models). Topics include survival functions, hazard functions, order statistics, continuous and discrete distributions not considered in Mathematics 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: Mathematics 253 (Probability Models)

Credits: 1/2

MAT 354 Mathematical Statistics

This course takes a more theoretical look at estimation and hypothesis testing than Mathematics 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 on an irregular basis.

Prerequisite: Mathematics 253 (Probability Models) and Mathematics 254 (Statistical Models)

Credits: 1/2

MAT 355 Regression Models

This course takes a matrix-based look at regression (introduced in Mathematics 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 normally offered in the spring semester; however, during the 2011-12 academic year, this course will be offered in the fall and not the spring.

Prerequisite: Mathematics 223 (Linear Algebra), Mathematics 253 (Probability Models) and Mathematics 254 (Statistical Models)

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.

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.

Prerequisite: Permission of the department.

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.

Prerequisite: Permission of the department.

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.

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.

Prerequisite: 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. Offered in the spring semester. Distribution in Natural Science and Mathematics or Quantitative skills. (Note: Computer Science 111 does not count as a laboratory science.)

Prerequisite: Computer Science 101 or permission of the instructor.

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 fall semester.

Prerequisite: Computer Science 111 or equivalent programming background.

Credits: 1

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: Computer Science 112.

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.

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: Computer Science 112.

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: Computer Science 112.

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: Computer Science 112 and Mathematics 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 alternate years. Next anticipated offerings will be fall semesters of 2012 and 2014.

Prerequisite: Computer Science 111 (or permission of the instructor) and Mathematics 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 inter-

disciplinary 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 alternate years. Next anticipated offerings will be fall semesters of 2011 and 2013.

Prerequisite: Computer Science 111. 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: Computer Science 111 and Mathematics 108 or 219.

Credits: 1

CSC 387 Independent Study

Directed study on special topics for qualified students. May be repeated for credit.

Prerequisite: Permission of the instructor.

Credits: 1/2

CSC 388 Independent Study

Directed study on special topics for qualified students. May be repeated for credit.

Prerequisite: Permission of the instructor.

Credits: 1/2

DEPARTMENT OF PHYSICS

Faculty: J. Brown (chair), D. Krause***, M. Madsen, L. Kinnaman

****Sabbatical, full year*

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 Physics 111, 112, 209, 210, 381, and 382. Of the four remaining physics course credits, two must come from the following set of advanced courses: Physics 310, 314, and 315. Physics 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 Chemistry 111 for the one elective physics course. Those planning to go on to graduate school in physics should plan to take Physics 230, 310, 314, and 315. In addition, mathematics courses that are prerequisites or co-requisites for physics courses are Mathematics 111 (or 110), 112, 223, 224, and 225. Although not required, Computer Science 111 is highly recommended, and Mathematics 324 and 344 are useful. Since physics is a hierarchical subject, it is important to take Physics 111 and 112 during the freshman year if one wishes to major in physics. Below is a possible schedule of how one might fulfill all the necessary requirements:

	<u>Fall Semester</u>	<u>Spring Semester</u>
Freshman	Physics 111 Mathematics 111	Physics 112 Mathematics 112
Sophomore	Physics 209 Mathematics 223	Physics 210 Mathematics 224
Junior	Physics elective Physics 381 Mathematics 225	Physics elective Physics 382
Senior	Physics elective	Physics elective

Elective courses regularly offered in the fall semester include Physics 220/230 (alternate years), Physics 310, and Physics 315, while regularly taught spring semester courses include Physics 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 Physics 210 with appropriate prerequisites. Any exceptions must receive prior approval from the department chair. Physics 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 Mathematics 111 (or 110) and 112.

An Area of Concentration in Education and Middle and High School Teaching licensure (grades 5-12) with this major is administered through the Teacher Education Program. For Education AOC and teaching licensure information, please see the *Teacher Education* section of the Academic Bulletin. Students are asked to consult with their academic advisor AND the Director of Teacher Education to learn more about course and licensure requirements.

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.

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/co-requisites: 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.

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.

Prerequisite: Mathematics 111 or 110 (or concurrent registration) or permission of instructor.

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.

Prerequisites: Physics 111.

Credits: 1

PHY 177 Special Topics

A special interest course on an introductory-level physics topic not covered in regular physics courses. Offered in the fall semester.

Prerequisites/co-requisites: 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. Offered in the spring semester.

Prerequisites/co-requisites: 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: Physics 112 and Mathematics 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: Physics 112 and Mathematics 223 (or concurrent registration or permission of the instructor).

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 alternate years in the fall semester. Next anticipated offerings will be fall semesters of 2012 and 2014.

Prerequisite: Physics 112 (or 114 which has been discontinued) or permission of the instructor.

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 alternate years in the fall semester. Next anticipated offerings will be fall semesters of 2011 and 2013.

Prerequisites: Physics 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. Offered in the fall semester. Student input as to the course topic will be sought prior to fall registration.

Prerequisite: To be 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. Offered in the spring semester. Student input as to the course topic will be sought prior to spring registration.

Prerequisite: To be determined by the topic.

Credits: 1 or 1/2

PHY 287 Independent Study

Independent Study. Offered in the fall semester.

Prerequisite: Permission of instructor.

Credits: 1 or 1/2

PHY 288 Independent Study

Independent Study. Offered in the spring semester.

Prerequisite: Permission of instructor.

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 or permission of the instructor.

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: Physics 111 (or permission of instructor) and Mathematics 224.

Credits: 1

PHY 314 Electrodynamics

Advanced explorations in understanding and applying Maxwell's equations. This course is offered in the spring semester.

Prerequisites: Physics 112 and Mathematics 224 and 225 (or permission of instructor).

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: Physics 210 and Mathematics 223 and 224 or permission of the instructor.

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: Physics 210 or permission of the instructor.

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: Physics 210 or permission of the instructor.

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: Physics 210.

Credits: 1/2

PHY 382 Advanced Laboratory

A continuation of PHY 381. This course is offered in the spring semester.

Prerequisite: Physics 381.

Credits: 1/2

PHY 387 Advanced Independent Study

Independent Study. Offered in the fall semester.

Prerequisite: Permission of instructor.

Credits: 1 or 1/2

PHY 388 Advanced Independent Study

Independent Study. Offered in the spring semester.

Prerequisite: Permission of instructor.

Credits: 1 or 1/2