SCHOOL OF NATURAL AND APPLIED SCIENCES

MARK L. BIERMANN, PH.D., DEAN

BIOLOGY

CHEMISTRY AND BIOCHEMISTRY

COMPUTER SCIENCE AND ENGINEERING

EARTH AND ENVIRONMENTAL SCIENCES

MATHEMATICS

PHYSICS AND ENGINEERING

Biology

Chair, Professor J. Reber
Professors T. Burkholder, J. Moore, J. Regier, P. Rothrock, A. Whipple
Instructor E. Hasenmyer

Taylor University has been a leader and at the forefront of Christian colleges in educating scientists in biology with strengths lying in preparation of students for graduate school, medical programs (medical & dental school and veterinary programs; physician assistant, physical therapy, public health and allied health programs) and science education. Our goal of developing biologists as leaders means that the department seeks to highly prepare its majors for the future by providing a strong foundation in biological science. The Department of Biology seeks to:

1. Provide students with a strong foundation in the essentials of biology with the opportunity to specialize in a particular field of biology. This is accomplished by:
    - Offering the breadth and quality of critically relevant course work necessary to prepare undergraduate biology majors for graduate and professional programs in the biological sciences.
    - Providing instruction by faculty with doctoral degrees.
    - Advising in specialty areas by advisors knowledgeable in those areas.
2. Thoroughly prepare students for future careers in the biological sciences by training them in the current knowledge, skills and processes of biological sciences. This is accomplished by:
    - Providing student opportunities within the biological sciences through practica and research experiences.
    - Continued faculty professional development as scholars, scientists, educators and role models by staying current in their profession and disciplines.
    - Examining the current program's approach, knowledge base, flexibility, equipment needs and integration of biology with other scientific disciplines; and implementing changes as needed.
3. Prepare Christian men and women for service to a world in need. This is accomplished by:
    - Presenting the essentials of modern, dynamic biology to students as part of the University general education curriculum.
    - Integrating faith and learning, including the continuing exploration of ethical implications in the application of modern biological science to the problems facing humankind today.

To fulfill the senior comprehensive examination requirement and be eligible for May graduation, majors are required to pass the biology subject test of the Graduate Record Exam (GRE) during the fall semester of their senior year.

Biology (BA)

The bachelor of arts degree with a major in biology requires two years of one foreign language and 51-53 hours in the major. (A minimum of 32 hours in the major must be from courses other than BIO 360, 393, 450, and 490.)

Major Requirements

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
BIO 493	4	Biology Senior Capstone
ENS 204	4	Principles of Ecology

Select six hours in the summer field studies program from:
(A minimum of four hours must be from courses other than BIO 393 and 450.)

BIO 302	4	Limnology
BIO 304	4	Field Natural History of the Black Hills
BIO 305	4	Natural History of the Rocky Mountains
BIO 313	4	Insect Biology and Ecology
BIO 323	4	Aquatic Biology
BIO 342	4	Fish Biology and Ecology
BIO 370	1-4	Selected Topics
BIO 393	2-4	Practicum
BIO 450	1-4	Directed Research

Additional Major Requirements
Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Electives
Select 15 hours from:

BIO 244	4	Human Anatomy and Physiology I
BIO 245	4	Human Anatomy and Physiology II
BIO 301	4	Taxonomy of Vascular Plants
BIO 307	4	Vertebrate Natural History
BIO 312	4	Cellular and Molecular Biology
BIO 322	3	Ornithology
BIO 331	4	Comparative Anatomy
BIO 360	1-4	Independent Study
BIO 370	1-4	Selected Topics
BIO 432	4	Developmental Biology
BIO 441	4	Environmental Physiology
BIO 450	1-4	Directed Research
BIO 452	4	Animal Physiology
BIO 462	4	Molecular Genetics
BIO 471	4	Microbiology and Immunology
BIO 472	4	Histology
BIO 490	1-2	Honors
CHE 411	3	Biochemistry I
ENS 231	4	Introduction to Environmental Science
ENS 475	4	Systems Ecology

In addition, the following courses are strongly recommended:
CHE 311/312, PHY 203/204 or PHY 211/212, and NAS 480

Biology/Systems (BS)

The bachelor of science degree with a major in biology/systems consists of the 51-53 hour bachelor of arts biology major and curriculum requirements in systems analysis. *All systems curriculum courses must be completed with a grade of C- or better.*

Systems Curriculum Requirements

COS 120	4	Introduction to Computer Science I
IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design
BIO 393	3-4	Practicum

Select one course from the following:

COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select one course from the following:

*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

Systems Electives

Select at least three hours of electives, in addition to those required in the major or systems.

COS 265	3	Data Structures and Algorithms
COS 382	3	Language Structures
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation
SYS 403	3	Operations Management

**Courses in both areas may count only once.*

Biology (BS)

The bachelor of science degree with a major in biology consists of 71 major hours.

Major Requirements

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
BIO 493	4	Biology Senior Capstone
ENS 204	4	Principles of Ecology

Select one course from the following:

BIO 393	2-4	Practicum
BIO 450	2-4	Directed Research

Select one course from the following:

BIO 302	4	Limnology
BIO 304	4	Field Natural History of the Black Hills
BIO 305	4	Natural History of the Rocky Mountains
BIO 313	4	Insect Biology and Ecology
BIO 322	4	Ornithology
BIO 323	4	Aquatic Biology
BIO 342	4	Fish Biology and Ecology
BIO 370	4	Selected Topics in Field Biology *(Pre-Approved)*

Select one course from the following:

BIO 312	4	Cellular and Molecular Biology
BIO 462	4	Molecular Genetics
BIO 471	4	Microbiology and Immunology
BIO 472	4	Histology

Select one course from the following:

BIO 331	4	Comparative Anatomy
BIO 432	4	Developmental Biology
BIO 441	4	Environmental Physiology
BIO 452	4	Animal Physiology

Select one course from the following:

BIO 301	4	Taxonomy of Vascular Plants
BIO 307	4	Vertebrate Natural History
ENS 475	4	Systems Ecology

Select one additional 300-/400-level biology course or CHE 411.

Additional Major Requirements

CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select one of the following physics course combinations:

PHY 203	4	General Physics I
PHY 204	4	General Physics II
or		
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select one of the following mathematics options:

MAT 151	4	Calculus I
MAT 210	4	Introductory Statistics
MAT 230	4	Calculus II (*or higher)*
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 and MAT 146 combination meets requirement

A minimum of 33 hours in the major must be from courses other than BIO 360, 393, 450, 490, or CHE 411.

Pre-Medicine Pre-Professional Program

Students are required to make formal application to the pre-medicine program in the spring semester of their sophomore year or after completion of 45 hours of course work. Students must have completed four of the five biology core courses, one year of chemistry, the math requirement, and have a cumulative GPA of 3.30. Each student will receive a copy of the Biology Student Handbook from his or her academic advisor.

Students interested in the pre-medicine curriculum should check out during their sophomore year the medical school admissions requirements for the school(s) to which they plan to apply. The Medical School Admission Requirements guide published annually by AAMC is the best resource for this information. It is important to meet the specific entrance requirements of the medical school(s) chosen.

Maintaining at least a 3.60 GPA and scoring well on the MCAT test (usually taken in the spring of the junior year) are common prerequisites for acceptance to a medical school. Assistance is available in preparing for the MCAT examinations.

Biology/Pre-Medicine Concentration (BA)

The bachelor of arts degree with a major in biology and a pre-professional concentration in pre-medicine requires two years, sequential study in one foreign language and 70-77 hours in the major.

Major Requirements

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
BIO 393	2-4	Practicum
BIO 493	4	Biology Senior Capstone
ENS 204	4	Principles of Ecology

Electives

Select four elective courses from:

BIO 312	4	Cellular and Molecular Biology
BIO 331	4	Comparative Anatomy
BIO 432	4	Developmental Biology
BIO 452	4	Animal Physiology
BIO 462	4	Molecular Genetics
BIO 471	4	Microbiology and Immunology
BIO 472	4	Histology
CHE 411	3	Biochemistry I

Select an additional 3-4 hours of upper-division biology electives.

Additional Major Requirements

CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select one of the following physics course combinations:

PHY 203	4	General Physics I
PHY 204	4	General Physics II
or		
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select one of the following mathematics options:

MAT 151	4	Calculus I
MAT 210	4	Introductory Statistics
MAT 230	4	Calculus II (*or higher)*
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†*MAT 145 and MAT 146 combination meets requirement*

Biology/Pre-Medicine Concentration (BS)

The bachelor of science degree with a major in biology and a pre-professional concentration in pre-medicine consists of 71-77 major hours.

Major Requirements

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
BIO 493	4	Biology Senior Capstone
ENS 204	4	Principles of Ecology

Select one course from the following:

BIO 393	2-4	Practicum
BIO 450	2-4	Directed Research

Select one course from the following:

BIO 312	4	Cellular and Molecular Biology
BIO 462	4	Molecular Genetics
BIO 471	4	Microbiology and Immunology

Select one course from the following:

BIO 331	4	Comparative Anatomy
BIO 432	4	Developmental Biology

Select one course from the following:

BIO 302	4	Limnology
BIO 304	4	Field Natural History of the Black Hills
BIO 305	4	Natural History of Rocky Mountains
BIO 313	4	Insect Biology and Ecology
BIO 322	4	Ornithology
BIO 323	4	Aquatic Biology
BIO 342	4	Fish Biology and Ecology
BIO 370	4	Selected Topics in Field Biology *(Pre-Approved)*

Select one course from the following:

BIO 441	4	Environmental Physiology
BIO 452	4	Animal Physiology

Select one additional 3-4 credit hour 300-/400-level biology course or CHE 411.

Additional Major Requirements

CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select one of the following physics course combinations:

PHY 203	4	General Physics I
PHY 204	4	General Physics II
or		
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select one of the following mathematics options:

†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus
MAT 151	4	Calculus I
MAT 210	4	Introductory Statistics
MAT 230	4	Calculus II (*or higher)*

†*MAT 145 and MAT 146 combination meets requirement*

Biology Science Education (BS)

The bachelor of science degree in biology science education requires 89-96 hours of professional education, required science, biology core, and elective courses. *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 310	2	Discipline and Classroom Management
*EDU 332	3	The Junior High/Middle School
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
NAS 309	2	Science Education Methods
SED 320	3	Exceptional Children

**EDU 332 is required only for those seeking licensure in junior high/middle school.*

Biology Core Courses

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
BIO 493	4	Biology Senior Capstone
ENS 204	4	Principles of Ecology

Science Core Courses

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select <u>one</u> course from the following:

PHY 203	4	General Physics I
PHY 211	4	University Physics I

Select <u>one</u> course from the following:

ENS 241	4	Physical Geology
ENS 242	4	Geology of Indiana
GEO 240	3	Introduction to Geology
PHY 204	4	General Physics II
PHY 212	5	University Physics II

Biology Electives

Select <u>one</u> field course from the following:

BIO 302	4	Limnology
BIO 304	4	Field Natural History of the Black Hills
BIO 305	4	Natural History of the Rocky Mountains
BIO 313	4	Insect Biology and Ecology
BIO 322	4	Ornithology
BIO 323	4	Aquatic Biology
BIO 342	4	Fish Biology and Ecology

Select <u>one</u> cell and molecular course from the following:

BIO 312	4	Cellular and Molecular Biology
BIO 432	4	Developmental Biology
BIO 462	4	Molecular Genetics
BIO 471	4	Microbiology and Immunology

Select <u>one</u> organismal biology course from the following:

BIO 244	4	Human Anatomy and Physiology I
BIO 245	4	Human Anatomy and Physiology II
BIO 331	4	Comparative Anatomy
BIO 441	4	Environmental Physiology
BIO 452	4	Animal Physiology

Select <u>one</u> ecological and population biology course from the following:

BIO 301	4	Taxonomy of Vascular Plants
BIO 307	4	Vertebrate Natural History
ENS 475	4	Systems Ecology

Select <u>one</u> biology experience course from the following:

BIO 393	2-4	Practicum
BIO 450	2-4	Directed Research

Select any course not taken from a previous area above or <u>four</u> hours from an additional 300- or 400-level biology course.

Biology Minor

A minor in biology requires 26-28 hours.

Minor Requirements

Select <u>three</u> courses from the following:

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 203	4	Principles of Genetics
ENS 204	4	Principles of Ecology

Additional Minor Requirements

MAT 210	4	Introductory Statistics

Select <u>one</u> course from the following:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I

Select an additional <u>eight hours</u> of upper-division (300-/400-level) biology courses.

AuSable Institute of Environmental Studies

Taylor University is affiliated with the AuSable Institute of Environmental Studies (AIES) in Mancelona, Michigan. Taylor students may take summer courses for credit at AIES. *Detailed information is available from the AIES representative of the Department of Biology.*

Biology Courses

BIO 100 **4 hours**
General Biology
Concepts and principles are studied to provide basic knowledge that assists students to meet the obligations of an informed citizen. The spring semester of General Biology is intended for elementary education majors as a content course that emphasizes instructional methodologies in science education. Three hours of lecture and two hours of laboratory per week. *Meets general education life science requirement; not available to biology majors.*

BIO 101 **4 hours**
Principles of Cell Biology
A majors core course: Study of generalized sub-cellular structures and metabolism emphasizing dependence of function on structure, principles of organization, and capture and utilization of energy. Three hours of lecture and two hours of laboratory per week. Meets general education life science requirement.

BIO 103 **3 hours**
Introductory Plant Biology
A majors core course: Introduction to plants taxonomy, physiology, and ecology; Archaea, algae, and fungi are introduced as well. The structure, growth, and development of the flowering plant body are emphasized. Two hours of lecture and two hours of laboratory per week. *Meets general education life science requirement.*

BIO 104 **3 hours**
Introductory Animal Biology
A majors core course: A taxonomic survey of the major phyla in the animal kingdom. Classification, characteristics, representative forms, and relations to man are considered. Invertebrates are emphasized. Two hours of lecture and three hours of laboratory per week. *Meets general education life science requirement.*

BIO 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. May count toward the departmental major and general education requirements.

BIO 200 **4 hours**
Human Nutrition
A study of human nutrition dealing with human consumption and utilization of food. An understanding of the basic roles of nutrients in the body creates an appreciation of the continuity of the life cycle with its changing nutritional needs. Three hours of lecture and two hours of laboratory per week. *Prerequisite: CHE 100 or permission of instructor. Meets general education life science requirement; not available to biology majors.*

BIO 203 **4 hours**
Principles of Genetics
A majors core course: Fundamental principles of Mendelian inheritance, introduction to molecular genetics, along with quantitative and evolutionary genetics will be examined. Three hours of lecture and two hours of laboratory per week. Does not normally satisfy general education science requirement.

BIO 205 **4 hours**
Human Biology
An introduction to the structure and function of the human body. This course focuses on the anatomy and physiology of human cells, tissues, organs, all organ systems, as well as the whole organism. Practical health applications will also be explored. *Meets general education life science requirement.*

BIO 243 **5 hours**
Human Anatomy and Physiology
A survey of the structure and function of the human organism. Biochemical composition, cellular structure, and tissue levels of organization and all the major systems are covered. Four hours of lecture and two hours of lab. *Meets general education life science requirement. Offered summer semester only.*

BIO 244 **4 hours**
Human Anatomy and Physiology I
The first of a two-course survey covering the structure and function of the human body. Biochemical composition, cellular structure, and tissue levels of organization, along with the integument, skeletal, muscular, and nervous systems are covered. Three hours of lecture and two hours of lab per week. *Meets general education life science requirement. Offered fall semester.*

BIO 245 **4 hours**
Human Anatomy and Physiology II
The second of a two-course survey covering the structure and function of the human body. The endocrine, cardiovascular, respiratory, digestive, urinary, and reproductive systems are covered. Three hours of lecture and two hours of lab per week. *Prerequisite: BIO 244. Offered spring semester.*

BIO 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. May count toward the departmental major and general education requirements.

BIO 301 **4 hours**
Taxonomy of Vascular Plants
Identification, classification, and systematics of vascular plants are studied. Topics include basic population genetics, the process of speciation, phylogeny reconstruction, and molecular patterns of diversification. Laboratory emphasis is on local flora, plant family characteristics, and modern systematic techniques. Two hours of lecture and four hours of laboratory per week. *Prerequisite: BIO 103; BIO 203 is recommended. Offered fall semester.*

BIO 302 **4 hours**
Limnology
Field Course: Field study of lakes and other freshwater systems with applications to planning and management. Includes an introduction to limnology and investigation of representative lakes, streams and wetlands of the region and compares the North American Great Lakes with other great lakes of the world and their stewardship. *Prerequisites: BIO 103, 104 and CHE 201 or 211. Offered summers at AIES.*

BIO 304 **4 hours**
Field Natural History of the Black Hills
Field Course: Introduction to basic field and lab methods used in field natural history. Includes basic nomenclature of spring flora and fauna in terrestrial as well as aquatic systems. Examines the principles of geology/paleontology, ecosystems, communities, and wildlife as exhibited in the Black Hills region of South Dakota, including Mt. Rushmore, Badlands National Park, Custer State Park, Devils Tower National Monument, the Black Hills National Forest, and Yellowstone and Grand Teton National Parks. *Prerequisites: BIO 103, 104, ENS 204, or permission of instructor. Offered summers at the Wheaton College Science Station, Black Hills South Dakota.*

BIO 305 **4 hours**
Natural History of the Rocky Mountains
Field Course: Natural History of the Rocky Mountains is a field study course of the ecology and natural history of the Rocky Mountains. Students study the varied life zones, geology, climatic, and soil interactions of the Sonoran Desert, Grand Canyon, Great Basin Desert, Great Salt Lake, Yellowstone, Grand Teton National Park, Pawnee Prairie, and Rocky Mountain National Park. Students will gain appreciation of God's creation. *Prerequisites: Completion of the biology core courses before enrolling or permission of the professor. Offered summer semester.*

BIO 307 **4 hours**
Vertebrate Natural History
This course looks at the adaptive anatomy, feeding relationships, behavior, life history, and geographical distribution of vertebrates from fishes to mammals. Labs focus on methods currently employed for study and observation of vertebrates in the field and involve several outdoor sessions. Three hours of lecture and three hours of lab per week. *Prerequisite: BIO 104 or permission of the instructor; ENS 204 is recommended. Offered spring semester.*

BIO 312 **4 hours**
Cellular and Molecular Biology
Analysis of the eukaryotic cell with regard to its physiological and biochemical characteristics, including bioenergetics, protein kinesis, cell communication, cell-division cycle, cell junctions and histology, cancer, and the adaptive immune system. Three hours lecture, one three-hour laboratory per week. *Prerequisites: BIO 101, CHE 201 or 211 and 202 or 212, and minimum junior status; or permission from the instructor.*

BIO 313 **4 hours**
Insect Biology and Ecology
Field Course: A study of insect taxonomy, ecology, life histories, and economic importance. Special attention is given to environmental stewardship issues, including use of insecticides, biological control, integrated pest management, and impact of cultivation on formation of pest faunas. Field methods are stressed. *Prerequisites: BIO 101, 104. Offered summers at AIES.*

BIO 322 **4 hours**
Ornithology
Field Course: Biology, behavior, ecology, and identification of birds. Work is primarily conducted in the field and covers the major habitats of northern lower Michigan, including wetlands, lakes, rivers, forests, dunes, and open field communities. Emphasis is placed on identification of the spring bird fauna of northern lower Michigan by sight and by call. *Prerequisites: One course in introductory biology and animal biology. Offered summers at AIES.*

BIO 323 **4 hours**
Aquatic Biology
Field Course: Collection, identification and ecological position of fresh-water organisms. Taxonomic skills are developed. *Prerequisites: BIO 103, 104, and ENS 204. Offered summers at AIES.*

BIO 331 **4 hours**
Comparative Anatomy
Classification, characteristics, and comparison of typical chordate animals with emphasis on the vertebrates. Lab contains detailed dissection of representative vertebrates. Three hours of lecture and three hours laboratory per week. Prerequisite: BIO 104 or permission of instructor. Offered fall semester.

BIO 342 **4 hours**
Fish Biology and Ecology
Field Course: Identification, ecology, exploitation and stewardship of fishes and their habitats. Field studies include noncommercial and commercial fisheries in the Great Lakes region, ecological dynamics of fisheries, exploitation and population ecology, fishing techniques, and fishing rights and regulations. *Prerequisites: BIO 101, 104, and ENS 204. Offered summers at AIES.*

BIO 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

BIO 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. May count toward the departmental major and general education requirements.

BIO 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

BIO 410 **3 hours**
Bioethics
An introduction to bioethics, comprising an overview of ethical theory, uniquely Christian contributions to ethical theory, and a consideration of specific bioethical problems. The interaction of bioethics in the worlds of ideologies, politics, and economics, and the unique contribution a Christian bioethical perspective brings to the public square, will also be foci of the course. Designed for upper level biology students, but open to any upper division student willing and able to acquire the necessary biological competence to knowledgably deal with the biology of the course material.

BIO 432 **4 hours**
Developmental Biology
A study of development at the molecular, cellular, and organismal levels. The lecture sessions focus on current concepts in developmental biology, and the lab is classical vertebrate embryology (frog, chick, pig). Three hours of lecture and three hours of laboratory per week. *Prerequisites: BIO 101 and 104; BIO 312 or 462 recommended. Offered fall semester.*

BIO 441 **4 hours**
Environmental Physiology
An introduction to the physiology of cells and tissues with emphasis on responses to environmental challenges. Topics include cell structure, protein synthesis and enzymes, water balance, transport, mineral nutrition, metabolism including photosynthesis, and responses to environmental cues stresses. Three hours of lecture and three hours of laboratory per week. *Prerequisites: BIO 103, CHE 201 and 202 or CHE 211 and 212. Offered spring semester.*

BIO 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

BIO 452 **4 hours**
Animal Physiology
A study of the physiological nature of living organisms with special consideration of the functions of vertebrate organ systems. Practical experience is given in working with live animals and the instrumentation used to examine the functional processes of various systems. Three hours of lecture and three hours of laboratory per week. *Prerequisites: BIO 331, CHE 201 and 202 or CHE 211 and 212. Offered spring semester.*

BIO 462 **4 hours**
Molecular Genetics
The current understanding of what a gene is, how it functions, and how it is regulated, particularly from a molecular perspective, is the essence of this course. Viral, prokaryotic, and eukaryotic systems are studied. Current scientific literature as well as a published textbook serve as sources. Three hours lecture and one four-hour laboratory per week. *Prerequisites: BIO 101 and 203; two courses in chemistry. BIO 471 is recommended. Offered fall semester.*

BIO 471 **4 hours**
Microbiology and Immunology
An introduction to general microbiology and to the human immune response. Included are microbial growth and control, diversity and taxonomy, the ecological role of microorganisms, and medical microbiology. The laboratory provides basic bacterial culture techniques, including the identification of unknowns. Three hours of lecture and three hours of laboratory per week. *Prerequisites: BIO 101, BIO 203, and two courses in chemistry are recommended. Offered spring semester.*

BIO 472 **4 hours**
Histology
The study of minute structure, composition, and function of tissue. Lectures and laboratories help expose students to both the normal tissue formation found in animal tissues (chiefly mammalian) and many of the abnormal tissue developments associated with pathological dysfunctions. *Prerequisites: Completion of the biology core courses before enrolling or permission of the instructor. Offered spring semester.*

BIO 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

BIO 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

BIO 493 **4 hours**
Biology Senior Capstone
An integrative, senior-level course in which major themes from within the biology major and from the Taylor general education program are intentionally revisited at a depth appropriate to college seniors. Such themes include the nature of biology as a natural science, the historical and philosophical foundations of the natural sciences, and the interaction and integration of biology with the Christian faith. Students will also actively engage in the process of doing current biological science, as well as consider several ethical issues that arise from current biology. *Prerequisite: Senior standing as a biology major. Offered January interterm.*

Notes

Chemistry and Biochemistry

Chair, Professor D. Hammond
Professors S. Burden, L. Kroll
Associate Professors D. King, D. Takehara
Assistant Professor P. Stan

The Department of Chemistry and Biocehmsitry at Taylor University provides high-quality training in chemistry and biochemistry while providing opportunities for meaningful spiritual and interpersonal experiences that will enable students to move successfully into the next phase of their professional training or the career of their choice.

The bachelor of arts degree in chemistry requires completion of two years, sequential study in one foreign language. Both the bachelor of arts and bachelor of science degrees are available in chemistry-environmental science.

Chemistry (BA)

The bachelor of arts degree with a major in chemistry requires two years of one foreign language and 60-66 hours in the major. This program is suitable for students wishing to enter either graduate school or the chemical industry.

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab
CHE 432	3	Physical Chemistry II
CHE 432L	1-2	Physical Chemistry II Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Major Requirements

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 and MAT 146 combination meets requirement.

Recommended Electives

CHE 412	3	Biochemistry II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
MAT 352	4	Mathematical Statistics
COS xxx		

NAS 480 is recommended in the junior or senior year.

Chemistry/Systems (BS)

The bachelor of science degree with a major in chemistry/systems consists of 52-56 hours in the major and curriculum requirements in systems analysis. This program is especially attractive to students planning to enter either graduate school or the chemical industry. *All systems curriculum courses must be completed with a grade of C- or better.*

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab
CHE 432	3	Physical Chemistry II
CHE 432L	1-2	Physical Chemistry II Lab

*Select <u>one</u> of the following chemistry course *combinations:*

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Major Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II

Systems Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
ENP 341	4	Microcomputer Interfacing
IAS 330	3	Human Relations in Organizations
MAT 230	4	Calculus II
MAT 382	3	Advanced Statistical Methods
ENP 331	4	Introduction to Electronics
SYS 101	3	Introduction to Systems
SYS 402	4	Modeling and Simulation
CHE 393	3-4	Practicum

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 and MAT 146 combination meets requirement.

Chemistry (BS)

The bachelor of science degree with a major in chemistry consists of 68 hours in the major and curriculum requirements in systems analysis. This program is especially attractive to students planning to enter either graduate school or the chemical industry.

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 412	3	Biochemistry II
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab
CHE 432	3	Physical Chemistry II
CHE 432L	1-2	Physical Chemistry II Lab
CHE 450	6	Directed Research

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Requirements

†MAT 151	4	Calculus I
†MAT 230	4	Calculus II
†PHY 211	4	University Physics I
†PHY 212	5	University Physics II

†Course does not count toward major GPA.

Recommended Electives

BIO 101	4	Principles of Cell Biology
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
MAT 352	4	Mathematical Statistics

Chemistry/Biochemistry Concentration (BA)

The bachelor of arts degree with a major in chemistry and a concentration in biochemistry requires two years of one foreign language and 68-71 hours. This program prepares students for a career in biochemistry, medicine, molecular biology and other related fields.

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 412	3	Biochemistry II
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Major Requirements

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II
BIO 101	4	Principles of Cell Biology

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 and MAT 146 combination meets requirement.

Electives

Select <u>two</u> elective biology courses (6 hours).

Chemistry/Pre-Medicine Concentration (BA)

The bachelor of arts degree with a major in chemistry and a pre-professional concentration in pre-medicine requires two years, sequential study of one foreign language and 67-73 major hours.

Students interested in the pre-medicine curriculum should check out during their sophomore year the medical school admissions requirements for the school(s) to which they plan to apply. The Medical School Admission Requirements guide published annually by AAMC is the best resource for this information. It is important to meet the specific entrance requirements of the medical school(s) chosen.

Maintaining at least an A- average and scoring well on the MCAT test (usually taken in the spring of the junior year) are common prerequisites for acceptance to a medical school. Assistance is available in preparing for the MCAT examinations.

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Major Requirements

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Select <u>three</u> biology courses from the following:

*BIO 101	4	Principles of Cell Biology
BIO 104	3	Introductory Animal Biology
*BIO 203	4	Principles of Genetics
BIO 312	4	Cellular and Molecular Biology
*BIO 331	4	Comparative Anatomy
BIO 432	4	Developmental Biology
*BIO 452	4	Animal Physiology
BIO 471	4	Microbiology and Immunology

**BIO 101; 203; and 331 or 452 are highly recommended.*

Recommended Elective

CHE 412	3	Biochemistry II

Chemistry/Systems—Pre-Medicine Concentration (BS)

The bachelor of science degree with a major in chemistry/systems and a pre-professional concentration in pre-medicine consists of the 67-73 major hours in addition to the curriculum requirements in systems analysis. *All systems curriculum courses must be completed with a grade of C- or better.*

Students interested in the pre-medicine curriculum should check out during their sophomore year the medical school admissions requirements for the school(s) to which they plan to apply. The Medical School Admission Requirements guide published annually by AAMC is the best resource for this information. It is important to meet the specific entrance requirements of the medical school(s) chosen.

Maintaining at least an A- average and scoring well on the MCAT test (usually taken in the spring of the junior year) are common prerequisites for acceptance to a medical school. Assistance is available in preparing for the MCAT examinations.

Major Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Additional Major Requirements

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Select <u>three</u> biology courses from the following:

*BIO 101	4	Principles of Cell Biology
BIO 104	3	Introductory Animal Biology
*BIO 203	4	Principles of Genetics
BIO 312	4	Cellular and Molecular Biology
*BIO 331	4	Comparative Anatomy
BIO 432	4	Developmental Biology
*BIO 452	4	Animal Physiology
BIO 471	4	Microbiology and Immunology

**BIO 101; 203; and 331 or 452 are highly recommended.*

Recommended Elective

CHE 412	3	Biochemistry II

Systems Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
ENP 341	4	Microcomputer Interfacing
IAS 330	3	Human Relations in Organizations
MAT 230	4	Calculus II
MAT 382	3	Advanced Statistical Methods
ENP 331	4	Introduction to Electronics
SYS 101	3	Introduction to Systems
SYS 402	4	Modeling and Simulation
CHE 393	3-4	Practicum

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Chemistry–Environmental Science (BS)

This integrated major has a strong emphasis on the physical aspects of environmental studies. It is appropriate for students planning careers in environmental research or industrial or municipal environmental monitoring and control. The bachelor of science degree with a major in chemistry–environmental science requires 90-92 major hours.

Chemistry Requirements

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 330	3	Inorganic Chemistry
CHE 410L	2	Biochemistry Lab
CHE 411	3	Biochemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab
CHE 432	3	Physical Chemistry II
CHE 432L	1-2	Physical Chemistry II Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Physics Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II

Environmental Science Requirements

CHE 320	3	Environmental Chemistry
CHE 320L	1	Environmental Chemistry Lab
ENS 204	4	Principles of Ecology
ENS 231	4	Introduction to Environmental Science
ENS 383	4	Environmental Ethics
ENS 402	4	Environmental Law and Policy

Select <u>one</u> course from the following:

CHE 393	2-4	Practicum
ENS 393	2-4	Practicum

Mathematics Requirements

MAT 230	4	Calculus II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Electives *(to total 90-92 major hours)*

CHE 412	3	Biochemistry II
MAT 210	4	Introductory Statistics
ENP 331	4	Introduction to Electronics
ENS 241	4	Physical Geology

Chemistry Education (BS)

The bachelor of science degree with a major in chemistry education requires 76-80 hours of professional education courses and major courses. *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Chemistry Courses

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 420	2	Chemistry Seminar
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Select at least <u>one</u> course from:

CHE 312	4	Organic Chemistry II
CHE 320	3	Environmental Chemistry
CHE 330	3	Inorganic Chemistry
CHE 411	3	Biochemistry I

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 310	2	Discipline and Classroom Management
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
NAS 309	2	Science Education Methods
SED 320	3	Exceptional Children

Additional Major Requirements

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Physical Science Education/Chemistry Concentration (BS)

The bachelor of science degree with a major in physical science and a concentration in chemistry requires 76-83 hours of professional education, physical science core and chemistry courses. *Majors must take CAS 110 to meet their general education speaking requirement.*

Physical Science Core

MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

(*CHE 211 and 212 are generally recommended)*

Chemistry Concentration

CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I
CHE 312	4	Organic Chemistry II
CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 310	2	Discipline and Classroom Management
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
*EDU 332	3	The Junior High/Middle School
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
NAS 309	2	Science Education Methods
SED 320	3	Exceptional Children

** EDU 332 is required only for those seeking licensure in junior high/middle school.*

Chemistry Minor

The chemistry minor requires a minimum of 21 hours and includes at least four semesters of core chemistry lab courses.

Minor Requirements

CHE 311	4	Organic Chemistry I

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II

**CHE 211 and 212 are generally recommended.*

Select <u>one</u> of the following chemistry course combinations:

†CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
or		
†CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
or		
†CHE 320	3	Environmental Chemistry
CHE 320L	1	Environmental Chemistry Lab
or		
CHE 330	3	Inorganic Chemistry

†Must be taken with Lab to meet requirement.

Electives

Select at least <u>two</u> upper-division (300/400-level) chemistry courses.

Chemistry Courses

CHE 100 **4 hours**
Chemistry for Living
A course designed for students who have little or no background in chemistry. Basic principles of chemistry are applied in a social context. Three hours of lecture and one two-hour lab per week. *Meets general education physical science requirement. No prerequisite, although high school algebra is recommended. Offered fall and spring semesters.*

CHE 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

CHE 201 **4 hours**
General Chemistry I
This is the first semester of a two-semester sequence designed for students with minimal backgrounds in chemistry. The two semesters are a comprehensive overview, with the first semester focusing on measurement, chemical reactions, stoichiometry, atomic structure, chemical bonds, molecular shapes, solutions, gases, thermochemistry, redox reactions, and phase changes. Descriptive chemistry and theory are integrated. A variety of applications are used, including astronomy, biology, medicine, geology, environmental chemistry, industrial chemistry, and everyday life. Common organic and inorganic compounds are used as examples. The labs are designed to illustrate concepts discussed in class, develop good lab skills, and enhance problem-solving ability. Designed for those needing a two-semester sequence of basic chemistry with lab. Three hours of lecture and three hours of lab per week. *Meets general education physical science requirement. No college level prerequisites, but high school algebra and chemistry are strongly recommended. Offered fall semester.*

CHE 202 **4 hours**
General Chemistry II
This is the second semester of a two-semester sequence designed for students with minimal backgrounds in chemistry yet need a solid foundation in chemistry for their major. Typically students who take the CHE 201/202 sequence are not planning to take more advanced courses in chemistry. The second semester focuses on chemical equilibrium, thermodynamics, acid-base chemistry, chemical kinetics, electrochemistry, organic chemistry, and biochemistry. Designed for those needing a two-semester sequence of basic chemistry with lab. Three hours of lecture and three hours of lab per week. *Prerequisite: CHE 201. Offered spring semester.*

CHE 211 **4 hours**
College Chemistry I
This is a general chemistry course for those intending to take later coursework in chemistry, such as organic, inorganic, analytical, or environmental chemistries. The course thoroughly explores the basic concepts and theories of chemistry, using quantitative skills to predict and characterize chemical properties and changes. The nature of atomic structure and chemical bonding and the properties of solids, liquids, and gases are all presented and studied using lectures, demonstrations, and computer-assisted teaching and testing methods. Chemical change is studied in terms of reaction classes, energy flows, and kinetic theories. *Meets the general education physical science requirement. Offered fall semester.*

CHE 212 **4 hours**
College Chemistry II
The second general chemistry course for those intending to take later coursework in chemistry, such as organic, inorganic, analytical, or environmental chemistries. This course thoroughly explores the basic concepts and theories of chemistry using quantitative skills to predict and characterize chemical properties and changes. The nature of organic chemistry, complexes, equilibria, electrochemistry, and advanced acid-base properties are all presented and studied using lectures, demonstrations, and computer-assisted teaching and testing methods. Chemical change is studied in terms of entropy, free energy, and kinetic theories. *Prerequisite: CHE 211. Offered spring semester.*

CHE 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

CHE 301 **3 hours**
Analytical Chemistry I
An introduction to modern theories and methods used in separations and quantitative determinations. Topics include basic statistics and treatment of data, gravimetry, volumetric titrations (acid-base, precipitation, complexometric, and redox). Topics correlate with the lab. Three hours of lecture per week. *Prerequisite: CHE 202. Corequisite: CHE 301L. Offered fall semester of odd years.*

CHE 301L **1 hour**
Analytical Chemistry I Lab
This lab includes gravimetric and volumetric (acid-base, precipitation, redox, nonaqueous complexometric) titrations. Some instrumentation is used: AA, GCMS, and computer-controlled titrators. Three hours of lab per week. *Prerequisite: CHE 202. Corequisite: CHE 301. Offered fall semester of odd years.*

CHE 302 **3 hours**
Analytical Chemistry II
A continuation of CHE 301 in which instrumental methods of analysis are emphasized. Topics include the general principles underlying selected instrumental methods of analysis. Topics supplement and expand the lab experiences. Three hours of lecture per week. *Prerequisite: CHE 301. Corequisite: CHE 302L. Offered spring semester of even years.*

CHE 302L **1 hour**
Analytical Chemistry II Lab
Lab experiences are offered that include optical methods (UV, VIS, AA), electrochemistry, and chromatography (HPLC, GC, IC, GC/MS). Three hours of lab per week. *Corequisite: CHE 320L. Offered spring semester of even years.*

CHE 311 **4 hours**
Organic Chemistry I
The study of covalent carbon compounds. Nomenclature, properties, and reactions (including reaction mechanisms) of all classes of hydrocarbons, alcohols, ethers, halides, and organometallic substances are studied. NMR and IR spectroscopic methods are learned and applied. The lab includes development of advanced lab skills and study of the kinetics and properties of organic substances in reactions. Three hours of lecture and three hours of lab. *Prerequisites: CHE 211, 212 (recommended) or CHE 201, 202. Offered fall semester.*

CHE 312 **4 hours**
Organic Chemistry II
Continuation of CHE 311. Focuses on carbonyl and carboxylate compounds and their derivatives, amines, and polyfunctional compounds, including biomolecules. Lab work includes study of the properties of aromatic compounds, qualitative organic analysis, and small group original research projects. Three hours of lecture and three hours of lab. *Prerequisite: CHE 311. Offered spring semester.*

CHE 320 **3 hours**
Environmental Chemistry
A course that emphasizes principles and analysis of chemical sources, movement, distribution, and effects in natural environments. *Prerequisite: One year of general chemistry. Corequisite: CHE 320L. Offered spring semester of even years.*

CHE 320L **1 hour**
Environmental Chemistry Lab
This lab provides experiences in sampling and analysis of water, soil, and air. Experimental work is conducted in both natural habitats and the lab. *Prerequisite: One year of general chemistry. Corequisite: CHE 320. Offered spring semester of odd years.*

CHE 330 **3 hours**
Inorganic Chemistry
Coverage of the bonding and properties of the main group and especially transition metal elements with a focus on their coordination and solid-state chemistry. Molecular symmetry principles, spectroscopy, and catalytic applications of these substances are discussed in lecture and studied in lab. Organometallic and bioinorganic chemistry are emphasized in lab studies. Two hours of lecture and three hours of lab. *Prerequisite: CHE 311. Offered each January interterm.*

CHE 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

CHE 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

CHE 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

CHE 410L **2 hours**
Biochemistry Lab
The lab uses a case study approach in which an enzyme is isolated and characterized in detail. The molecular genetics, structure, regulation, and kinetics of the enzyme are studied using a wide range of techniques. This course is designed for chemistry and biology majors with a background in organic chemistry. There will be some lecture, but the primary experience will be in the lab. *Prerequisite: CHE 411 or consent of instructor. Cell biology is strongly recommended. Offered January interterm.*

CHE 411 **3 hours**
Biochemistry I
An introduction to the principles of biochemistry in which conformation and biosynthesis of macromolecules, bioenergetics, molecular genetics, and techniques of separation and analysis are studied. This course is designed for chemistry and biology majors with a background in organic chemistry. Three hours of lecture per week. *Prerequisite: CHE 311 or consent of instructor. Cell biology is strongly recommended. Offered fall semester.*

CHE 412 **3 hours**
Biochemistry II
This course is a continuation of CHE 411. The emphasis is on metabolism, molecular genetics, and molecular physiology. This course is designed for chemistry and biology majors with a background in organic chemistry. Three hours of lecture per week. *Prerequisite: CHE 411 or consent of instructor. Cell biology is strongly recommended. Offered spring semester.*

CHE 420 **2 hours**
Chemistry Seminar
In this course, students complete their senior papers, develop and give an oral presentation of this material, and then defend it orally. Discussion and readings on issues related to science and faith are also included. *Prerequisite: Successful completion of fall term paper writing workshop (0 hrs. credit). Required of all chemistry seniors. Offered January interterm.*

CHE 431 **3 hours**
Physical Chemistry I
An introduction to the kinetic-molecular theory of gases, the principles of thermodynamics, solutions, electrochemistry, and chemical kinetics. The course is designed for chemistry and physics majors. *Prerequisites: CHE 201 and 202 or 211 and 212; PHY 211, 212; and MAT 146 or 151, 230. Corequisite: CHE 431L. Offered fall semester of even years.*

CHE 431L **1-2 hours**
Physical Chemistry I Lab
A lab course that includes vacuum techniques, thermometry and thermoregulation, calorimetry, physical characterization of solutions, and optical techniques. Students opting for two hours apply these techniques to a project. Three to six hours of lab per week. *Corequisite: CHE 431L. Offered fall semester of even years.*

CHE 432 **3 hours**
Physical Chemistry II
Emphasis on elementary principles of quantum mechanics, molecular structure, spectroscopy, and photochemistry. The course is designed for chemistry and physics majors. Three hours of lecture per week. *Prerequisites: CHE 201and 202 or 211 and 212; PHY 211, 212; and MAT 146 or 151, 230, with MAT 240, 251, 351 strongly recommended. Corequisite: CHE 432L. Offered spring semester of odd years.*

CHE 432L **1-2 hours**
Physical Chemistry II Lab
Same content as CHE 431L. Students who have taken CHE 431L for one-hour credit do a project in CHE 432L. No student may have more than two hours total lab credit from CHE 431L and CHE 432L. Three to six hours of lab per week. *Corequisite: CHE 432. Offered spring semester of odd years.*

CHE 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

CHE 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

CHE 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

Computer Science and Engineering

Chair, Professor W. Toll
Professors F. Aguilar, A. White
Associate Professors S. Brandle, J. Cramer, J. Geisler, T. Nurkkala

In support of the overall University Mission, the mission of Computer Science and Engineering is to educate men and women who sense God's calling to technical professions in the disciplines of Computer Science, Systems, and Computer Engineering.

Six baccalaureate majors are offered by the department:

- **Computer Science (BA)**
- **Computer Science (BS)**
  Designed primarily for students wishing to pursue graduate study in computer science.
- **Computer Science/Systems (BS)**
  Systems analysis requirements in addition to the computer science curriculum of the BA.
- **Computer Science—New Media (BA)**
  Computer Science core with courses from Computer Science, Art, and Communication Arts emphasizing media use and computation.
- **Computer Science—New Media/Systems (BS)**
  Systems analysis requirements in addition to the Computer Science-New Media curriculum.
- **Computer Engineering (BS)**
  Combination of fundamental engineering, computer science, and electronics curricula. Program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

The department has cooperated with the Center for Research and Innovation and the School of Business in developing an entrepreneurial curriculum. Computer science majors interested in this area are encouraged to pursue the entrepreneurship minor offered by the School of Business. The proper choice of concentration and electives within the computer science major allows the student to select courses that also apply to the entrepreneurship minor.

Systems for Bachelor of Science Degree

Program Director, Professor F. Aguilar

The purpose of the systems curriculum, coordinated by the Computer Science and Engineering department and combined with the courses in the major and the general education curriculum, is to prepare a student to acquire the knowledge and skills of a systems analyst. A systems analyst attempts to help an organization solve a problem, take advantage of an opportunity, or follow a directive coming from upper management, ownership, or the government in an effective and efficient manner. Analysts play a significant role in organizational development and operation of systems. In order to do so, they assist and frequently lead the effort to plan, analyze, design, implement and support the systems and improvements to them.

Systems analysts are required to know about information technology and its uses, how and why the organization functions, and the environment in which the organization carries out its mission. Analysts must also possess skills that allow them to speak and write effectively, work with others in projects, and be able to solve problems both in individual and group settings.

Systems may be combined with any baccalaureate major. Graduates have used what they have learned in systems in a variety of arenas, including those work-related and those of further formal education. For example, computer science graduates have designed computer-related solutions to take advantage of the interconnectedness of businesses that the Internet allows; business administration graduates have analyzed companies for their roles in the global business environment to determine if investment in them is wise for their clients; and accounting graduates have assisted organizations and individuals in making intelligent systematic decisions regarding federal, state and local taxes.

Others have used their systems knowledge in their endeavors in graduate school. For example, psychology graduates have used what they learned in advanced statistics to conduct their graduate statistical studies regarding human behavior; chemistry and physics majors have designed research projects more efficiently; and mathematics majors have applied their knowledge in studies of actuarial science.

Students choosing a career in systems analysis may combine any baccalaureate major with the systems analysis curriculum. *All courses required by the systems curriculum must be completed with a grade of C- or better.*

Systems Requirements

Systems Curriculum Requirements

COS 120	4	Introduction to Computer Science I
IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design
SYS 403	3	Operations Management
xxx 393	3-4	Practicum

Select <u>one</u> course from the following:

COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select <u>one</u> course from the following:

*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

Systems Electives

Select at least <u>three</u> hours of electives, in addition to those required in the major or systems.

COS 265	3	Data Structures and Algorithms
COS 382	3	Language Structures
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

**Course may not count in both areas.*

Depending on the student's major and other areas of interest, other courses may be required in addition to or substituted for those listed above. For example, mathematics, physics, and chemistry majors take a different sequence of mathematics courses and may elect to take a computer science course other than COS 121 or 240, subject to Computer Science and Engineering departmental approval. Business majors are not required to take IAS 330. *See academic departments (pages 59-231) for specific curriculum requirements.*

Computer Science (BA)

The bachelor of arts degree with a major in computer science requires the completion of two years of one foreign language and 71 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project except for students in the Software Studio concentration where they are included in COS 472 Software Studio IV.

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 341	4	Database Concepts
*COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

**Not required for Software Studio concentration.*

Select <u>one</u> course from the following:

COS 320	3	Algorithm Design
COS 382	3	Language Structures
COS 435	3	Theory of Computation

Select <u>one</u> course from the following:

COS 393	4	Practicum
COS 452	3	Research I

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Electives: *(Courses fulfilling concentration requirements may not also be used as electives.)*

Select additional electives to complete the 71 total hour requirement from the following:
COS 230, 240, 280, COS 300-/400-level courses
SYS 214, 352, 401, 402, 403, 411

Select <u>one</u> of the following concentration areas:

Graphics

SYS 214	3	Principles of Human Computer Interaction
COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
COS 425	3	Animation

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence
COS 351	3	Computer Vision
COS 380	3	Natural Language Processing
SYS 352	3	Knowledge Based Systems
SYS 411	3	Machine Learning

Scientific Computing

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis

Software Studio

COS 340	3	Software Engineering
*COS 371	4	Software Studio I
COS 372	4	Software Studio II
COS 471	4	Software Studio III
COS 472	4	Software Studio IV

**COS 371 requires SYS 390 which does not count toward the major.*

Computer Science (BS)

The bachelor of science degree with a major in computer science requires the completion of 87 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 453 Research II.

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 310	1	Current Literature Survey
COS 311	2	Ethics in Computer Science
COS 320	3	Algorithm Design
COS 341	4	Database Concepts
COS 382	3	Language Structures
COS 435	3	Theory of Computation
COS 452	3	Research I
COS 453	3	Research II
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select <u>two</u> courses from the following:

COS 381	3	Computer Architecture
COS 421	3	Operating Systems
COS 436	3	Distributed Processing

***Electives**: (Courses fulfilling concentration requirements may not also be used as electives.)*
Select enough electives to complete the 87-hour total requirement from:
COS 230, 240 and 280, 300-/400-level course except COS 393
SYS 214, 352, 401, 402, 403, 411

Select one of the following concentration areas:

Graphics

COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
COS 425	3	Animation
SYS 214	3	Principles of Human Computer Interaction

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence
COS 351	3	Computer Vision
COS 380	3	Natural Language Processing
SYS 352	3	Knowledge Based Systems
SYS 411	3	Machine Learning

Scientific Computing

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis

Software Studio

COS 340	3	Software Engineering
COS 371 *	4	Software Studio I*
COS 372	4	Software Studio II
COS 471	4	Software Studio III
COS 472	4	Software Studio IV

**COS 371 requires SYS 390 which does not count toward the major.*

Computer Science/Systems (BS)

The bachelor of science degree with a major in computer science/systems consists of the 71 hour major requirement and curriculum requirements in systems analysis. All systems curriculum courses must be completed with a grade of C- or better. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project except for students in the Software Studio concentration where they are included in COS 472 Software Studio IV. *Courses fulfilling major core, systems, concentration or elective requirements will not meet more than one requirement.*

Core Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 341	4	Database Concepts
COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems

Select *one course from the following:*

COS 320	3	Algorithm Design
COS 382	3	Language Structures
COS 435	3	Theory of Computation

Select *one course from the following:*

COS 393	4	Practicum
COS 452	3	Research I

Select *one course from the following:*

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

**Not required for Software Studio concentration.*

Major Electives

Select enough electives to meet the 71 total hour requirement from: COS 230, 240, 280, 300-/400-level courses SYS 314, 352, 401, 403, 411.

Systems Requirements

IAS 330	3	Human Relations in Organizations
MAT 382	3	Advanced Statistical Methods
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 402	4	Modeling and Simulation

Select *one course from the following:*

COS 372	4	Software Studio II
SYS 394	3	Information Systems Design

Select *one course from the following:*

SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
SYS 401	4	Operations Research
SYS 403	3	Operations Management
ENT 420	3	Creativity and Concept Development

Select one of the following concentration areas: *(Courses fulfilling concentration requirements may not also be used as electives.)*

Business Information Systems

COS 240	3	Business Application Programming
COS 340	3	Software Engineering
MGT 201	3	Business Basics Boot Camp
SYS 214	3	Principles of Human Computer Interaction

Choose one of the following;

ACC 241	3	Principles of Accounting
ENT 422	3	New Venture Planning

Graphics

SYS 214	3	Principles of Human Computer Interaction
COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
COS 425	3	Animation

Intelligent Systems

COS 280	3	Introduction to Artificial Intelligence
COS 351	3	Computer Vision
COS 380	3	Natural Language Processing
SYS 352	3	Knowledge Based Systems
SYS 411	3	Machine Learning

Scientific Computing

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis

Software Studio

COS 340	3	Software Engineering
COS 371	4	Software Studio I
COS 372	4	Software Studio II
COS 471	4	Software Studio III
COS 472	4	Software Studio IV

Computer Science Minor

A computer science minor requires 32 hours.

Minor Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 311	2	Ethics in Computer Science
COS 331	3	Data Communications
COS 341	4	Database Concepts
MAT 215	3	Discrete Mathematics for Computer Science
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis

Select <u>one</u> course from the following:

COS 240	3	Business Application Programming
COS 280	3	Introduction to Artificial Intelligence
COS 350	3	Computer Graphics
SYS 394	3	Information Systems Design

Computer Science–New Media (BA)

The bachelor of arts degree with a major in computer science–new media consists of two years of one foreign language and 64 hours in the major. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project.

Core Requirements

ART 152	3	Visual Communication
ART 154	1	Digital Tools: Illustrator
ART 156	1	Digital Tools: Photoshop
ART 158	1	Digital Tools: Dreamweaver
ART 159	1	Digital Tools: Flash
ART 253	3	Digital Photography
ART 356	3	Web Design
ART 456	3	Web Animation
COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 264	3	Interactive Application Development
COS 265	3	Data Structures and Algorithms
COS 311	2	Ethics in Computer Science
COS 314	3	Human Computer Interaction
COS 350	3	Computer Graphics
COS 393	4	Practicum
COS 425	3	Animation
COS 492	3	Senior Project
COS 493	1	Computer Science Senior Capstone
SYS 214	3	Principles of Human Computer Interaction
CNM 215	3	Digital Audio Production
CNM 220	3	Digital Video Production

Select <u>one</u> course from the following:

COS 331	3	Data Communications
COS 341	3	Database Concepts
COS 351	3	Computer Vision
COS 424	3	Surfaces and Modeling
SYS 310	3	E-Commerce

Select <u>one</u> course from the following:

ART 151	3	Two Dimensional Design
ART 251	3	Typography
ART 353	3	Digital Photography II
CNM 330	3	Scriptwriting
CNM 345	3	Web Writing and Production

Computer Science–New Media/Systems (BS)

The bachelor of science degree with a major in computer science–new media consists of the 64 hour major requirement and curriculum requirements in systems analysis. All systems curriculum courses must be completed with a grade of C- or better. Majors are required to pass a comprehensive examination during their senior year. This examination includes an implementation project, written and oral presentation of this work, and an oral examination over coursework in the major field. The project and presentation portions of this examination are included in COS 492 Senior Project.

Systems Requirements

IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 310	3	E-Commerce
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar

Select <u>one</u> course from the following:

COS 372	4	Software Studio II
SYS 394	3	Information Systems Design

Select <u>one</u> course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select <u>one</u> course from the following:

ENT 422	3	New Venture Planning
SYS 401	4	Operations Research
SYS 402	4	Modeling and Simulation
SYS 403	3	Operations Management

Computer Engineering (BS)

Intimate knowledge of both physics and computer science is the foundation of the design and development of powerful and efficient embedded computer systems. The computer engineering major is offered jointly by the computer science and engineering & physics and engineering departments and focuses on the theoretical and applied operation of computer hardware and software.

The computer engineering program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

Program Objectives:

1. Develop Christian leaders who serve God and humanity through active service to their family, church, job and global community.
2. Develop competent computer engineers who work in situations in which they apply their broad understanding of computer science, engineering, physics and mathematics.
3. Develop computer engineers who engage in lifelong learning by applying and adapting their understanding of fundamental principles in a constantly changing field.
4. Develop computer engineers who utilize their project experience to solve complex engineering problems using a formal design methodology.
5. Develop computer engineers with a strong work ethic, good communication skills, and who act in an ethically responsible manner.

The bachelor of science degree with a major in computer engineering requires 96 hours. Majors are required to pass a comprehensive examination during their senior year. This examination includes a major design and implementation project (COS 491, 494, 495), written and oral presentation of this work, and an oral examination over coursework in the major field.

Physics and Engineering Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II
ENP 104	2	Introduction to Engineering and Software Tools
ENP 252	4	Principles of Engineering
ENP 321	2	Applied Electromagnetics
ENP 331	4	Introduction to Electronics
ENP 332	4	Control Systems
ENP 333	3	Introduction to Solid State Devices
ENP 341	4	Microcomputer Interfacing
ENP 431	4	Advanced Electronics and Microcircuits

Mathematics Requirements

MAT 151	4	Calculus I
MAT 215	3	Discrete Mathematics for Computer Science
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
MAT 352	4	Mathematical Statistics

Computer Science Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 265	3	Data Structures and Algorithms
COS 284	3	Introduction to Computer Systems
COS 311	2	Ethics in Computer Science
COS 331	3	Data Communications
COS 340	3	Software Engineering
COS 381	3	Computer Architecture
COS 393	2	Practicum
COS 421	3	Operating Systems
COS 491	2	Senior Engineering Project I
COS 493	1	Computer Science Senior Capstone
COS 494	3	Senior Engineering Project II
COS 495	1	Senior Engineering Project III

Management Information Systems (AA)

An associate of arts degree with a major in management information systems has been developed for those who wish to become information systems specialists. Students enrolled in this 2-year program are preparing for vocations in the fields of computer programming and information systems. The sequence includes a combination of business, computer science, and systems analysis courses built around a core of liberal arts studies. In the 4-course sequence of SYS 101, 390, 394 and COS 393, the student approaches systems in general and management information systems in particular and completes a practicum in a systems environment outside of Taylor University. The degree program requires 67-71 hours.

Course Requirements

ACC 241	3	Accounting Principles I
ACC 242	3	Accounting Principles II
BIB 110	3	Biblical Literature I
BIB 210	3	Biblical Literature II
COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming
COS 393	4	Practicum
ENG 110	3	Expository Writing
IAS 101	1	New Student Orientation
IAS 110	3	Foundations of Christian Thought
IAS 330	3	Human Relations in Organizations
MGT 352	3	Management Analysis and Practice
MAT 210	4	Introductory Statistics
PHP 100	1	Fitness for Life
PHP 200	1	General Physical Education
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design

Select <u>one</u> course from the following:

CAS 110	3	Public Speaking
CAS 120	3	Interpersonal Communication

Select <u>one</u> course from the following:

COS 104	2	Computing and Information Concepts
COS 106	2	Computing and Information Concepts

Select <u>one</u> course from the following:

HUM 230	4	Art as Experience
ENG 230	3	World Literature
ENG 240	3	American Literature
ENG 250	3	British Literature

Select <u>one</u> course from the following:

*MAT 110	3	Finite Mathematics
MAT 151	4	Calculus I

**MAT 110 will not meet the systems requirement for a baccalaureate degree.*

Computer Science Courses

COS 104 **2 hours**
Computing and Information Concepts
An introduction to computing issues, information technology, and the field of computer science designed to provide a foundation for future course work directly related to the student's major. Topics discussed include hardware and software, operating systems, graphical user interfaces, data storage technologies, local and network information access, spreadsheets, concepts of computation, and ethical issues. The course is designed for those with little or no previous computer experience. Credit may not be earned in both COS 104 and COS 106. Two hours of lecture and one hour of lab. *Meets general education requirement.*

COS 106 **2 hours**
Computing and Information Concepts
An introduction to computing issues, information technology, and the field of computer science designed to provide a foundation for future course work directly related to the student's major. Topics discussed include hardware and software, operating systems, graphical user interfaces, data storage technologies, local and network information access, advanced spreadsheets, concepts of computation, and ethical issues. The course is designed for those with significant previous computer experience. Credit may not be earned in both COS 104 and COS 106. Two hours of lecture and one hour of lab. *Meets general education requirement.*

COS 120 **4 hours**
Introduction to Computer Science I
Problem solving and computer programming are stressed. Algorithms for text processing, information retrieval, mathematical manipulation, sorting, file handling, and introductory data structures are presented. Good algorithm design, style, program structure, documentation, code reading, and introductory software engineering techniques are emphasized. Three hours of lecture and two hours of lab per week. *Does not count as a general education requirement.*

COS 121 **4 hours**
Introduction to Computer Science II
This course is a continuation of COS 120 and includes the introduction of object-oriented programming, simple data structures such as lists, stacks, queues, and trees, and an introduction to computational complexity. Three hours of lecture and two hours of lab per week. *Prerequisite: COS 120.*

COS 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

COS 230 **3 hours**
Missions Technology
A survey and in-depth study of technology applied to Christian missions. Theory and issues in application are developed. Interaction with missions agencies and a practical project are included. *Prerequisites: COS 120.*

COS 240 **3 hours**
Business Application Programming
File types and data structures typically found in business information systems are investigated. Students are given the opportunity to implement various application solutions. Most commonly used features of the Visual Basic language and GUI design are presented and practiced. Basic database concepts and database/interface integration are emphasized. *Prerequisites: COS 120, SYS 101.*

COS 264 **3 hours**
Interactive Application Development
Design and implementation for interactive computer applications are studied. Topics include web interaction, security, two- and three-tier applications, client-side and server-side scripting and event-based programming. XHTML, CSS, Perl, PHP, Javascript (including AJAX), MySQL, XML and other tools are utilized. *Prerequisite: COS 121.*

COS 265 **3 hours**
Data Structures and Algorithms
A survey of data structures and algorithms that operate on them, with an emphasis on abstract data types and analysis of computational complexity. *Prerequisite: COS 121.*

COS 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

COS 280 **3 hours**
Introduction to Artificial Intelligence
A survey of the field of artificial intelligence. Major areas of exploration include search, logic, learning, knowledge representation, problem solving, natural language processing, computer vision, robotics, expert systems, and neural networks. An introduction to LISP is included. *Prerequisite: COS 121.*

COS 284 **3 hours**
Introduction to Computer Systems
This course provides an integrated introduction to computer hardware architecture, operating systems, and their interaction. Assembly language and operating system programming are emphasized. *Prerequisite: COS 121, MAT 215.*

COS 310 **1 hour**
Current Literature Survey
A survey of classical and current literature in computer science. A goal of the course is to produce a concept for a research proposal with literature survey appropriate for an undergraduate research project. Students lead discussions on papers and topics of interest. *Prerequisite: one 300-level COS course.*

COS 311 **2 hours**
Ethics in Computer Science
A study of the ethical implications of computers in society and the role of Christians as computer science and engineering professionals. Several of the major ethical issues in the field, such as privacy, piracy, liability, equity, and whistle-blowing are explored. Professional society codes of conduct are examined and discussed. Legal and ethical issues such as piracy, copyright and fair use related to media are also addressed. Ethical concerns of computer science and systems analysis and their relationship to one's faith are an integral part of this course.

COS 314 **3 hours**
Human Computer Interaction

This course builds on concepts from SYS 214 and implementation techniques from COS 264 as well as introducing additional implementation strategies. Interfaces for web and standalone applications are studied and implemented. *Prerequisites: SYS 214, COS 264.*

COS 320 **3 hours**
Algorithm Design
Algorithms and related data structures from a variety of areas are examined and analyzed. Parallel processing paradigms and theoretical topics, such as complexity models, are introduced. *Prerequisites: COS 265, MAT 215.*

COS 331 **3 hours**
Data Communications
A study of the nature and applications of data communications in use today. Fundamental concepts of types, modes, and media of transmission are studied. Communication protocols and their encompassing architectures are analyzed and compared. Practical applications of data communications concepts are demonstrated through networking projects and development of communications software. *Prerequisite: COS 121.*

COS 340 **3 hours**
Software Engineering
A study of the concepts, procedures, and tools of large system software project development, including project estimation and management, software technical metrics, configuration management, and software testing. Concepts of software engineering are introduced using the development of a large software system as an instructional illustration. The project is designed and its development managed using the methods and techniques examined in the course. *Prerequisite: COS 121.*

COS 341 **4 hours**
Database Concepts
A study of the fundamental concepts of relational database technology. Topics include data modeling, physical database design with emphasis on implementing integrity constraints, SQL query language, stored procedures and triggers, indexes, and transaction management. Students work primarily with the SQL Server database product. *Prerequisites: COS 121, SYS 101, MAT 215.*

COS 342 **3 hours**
Information Security
An overview of the issues involved in making information secure, including policies, protection models, authentication, auditing, intrusion detection, and access control. The design and implementation of secure software is emphasized. *Prerequisite: COS 121.*

COS 350 **3 hours**
Computer Graphics
An introductory course in computer graphics with an emphasis on 3D image production using a variety of approaches, including OpenGL programming. Basic algorithms, data structures, and GUI programming are introduced. *Prerequisite: COS 121.*

COS 351 **3 hours**
Computer Vision
A study of the fundamental concepts of digital image acquisition, manipulation, enhancement, representation, analysis and understanding. *Prerequisite: COS 121. Offered spring semester of even years.*

COS 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

COS 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements. Prerequisites: Two courses in computer science.*

COS 371 **4 hours**
Software Studio I
The first course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio I and III will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the two year span of this set of courses. Department approval is required based on student ability and the availability of appropriate projects. *Corequisites: SYS 390.*

COS 372 **4 hours**
Software Studio II
The second course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio II and IV will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the 2 year span of this set of courses. *Prerequisite: COS 371.*

COS 380 **3 hours**
Natural Language Processing
A study of the automation of human communication abilities, covering both textual and vocal aspects. Major topics include language understanding, representation, enhancement, generation, translation, and speaker/author recognition. *Prerequisite: COS 280. Offered spring semester of odd years.*

COS 381 **3 hours**
Computer Architecture
A study of the hardware structure of computer systems, including arithmetic/logic units, memory organization, control unit design, pipelining, and instruction set design. A brief introduction to advanced topics, such as out-of-order execution, branch prediction, multi-core systems, and parallel processing will prepare the student for graduate level courses in architecture. *Prerequisites: COS 284, MAT 215.*

COS 382 **3 hours**
Language Structures
A study of the features and implementation issues of programming languages, including a survey of language paradigms. Grammars, syntax, semantics, translation, lexical analysis, and parsing are introduced. *Prerequisite: COS 265.*

COS 393 **4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Practicum course credit requires 320 hours of work experience. *Grade only. Offered primarily during summer.*

COS 421 **3 hours**
Operating Systems
A study of the design considerations of computer operating systems and their interaction with hardware features. Topics covered include process management, storage management, protection and security, and distributed systems. *Prerequisites: COS 265, 284.*

COS 424 **3 hours**
Surfaces and Modeling
An advanced graphics course with emphasis on curve and surface representation and geometric modeling. Mathematics and algorithms are studied. Topics include Bezier and B-spline curves and surfaces and geometric modeling techniques. *Prerequisite: COS 350.*

COS 425 **3 hours**
Animation
An advanced graphics course with emphasis on techniques for rendering and animation. Mathematics and algorithms are studied. Topics include light and illumination models, ray tracing, methods to enhance realism, and standard animation techniques. A professional software package will be used to create a significant animation. *Prerequisite: COS 350.*

COS 435 **3 hours**
Theory of Computation
A theoretical treatment of what can be computed and how efficiently computation can be done. Topics include models of computation and automata, deterministic and non-deterministic computations, and formal language theory. *Prerequisite: COS 265*

COS 436 **3 hours**
Distributed Processing
A study of concepts and models of distributed and parallel computing, including concurrency, synchronization, theoretical design, algorithms, implications of hardware organization, clusters, grid computing, and common programming environments. *Prerequisite: COS 265.*

COS 450 **1-4 hours**
Directed Research
Independent or small group projects. *May be taken by any COS major with instructor approval.*

COS 452 **3 hours**
Research I
Participation in a research project under faculty direction. May be repeated. *Permission of the instructor required.*

COS 453 **3 hours**
Research II
Participation in a research project under faculty direction. A formal presentation of results is required. *Permission of the instructor required.*

COS 471 **4 hours**
Software Studio III
The third course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio I and III will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the two year span of this set of courses. This course may not count as an elective for any of the COS majors. *Prerequisite: COS 372.*

COS 472 **4 hours**
Software Studio IV
The fourth course in a sequence of four courses that provide extended project development experience utilizing the studio model. Students learn the craft of software development by working in various capacities on real long-term projects. The expected work load for this course includes one hour per week in a seminar format, two hours per week in reading and writing papers, and nine documented hours per week of work on the assigned project. The seminar portion of the course is organized so that students enrolled in Software Studio II and IV will meet as a group to consider topics that rotate on a two-year cycle so that students are exposed to all topics over the two year span of this set of courses. This course may not count as an elective for any of the COS majors. This course includes significant written and oral project summary and serves as the senior project course for BA and BS/Systems COS majors in the Software Studio track. *Prerequisite: COS 471.*

COS 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

COS 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

COS 491 **2 hours**
Senior Engineering Project I
The course is the first of a three course culminating experience preparing students for engineering practice through a major design and implementation project. Prerequisite: senior status, CEN major.
Offered fall semester.

COS 492 **3 hours**
Senior Project
Designed to exercise each senior's technical analysis design and development of skills and showcase his/her documentation and presentation skills. The student develops a project through multiple phases of the software lifecycle frequently beginning at the design stage. The project is typically chosen to reflect the student's area of concentration. *Prerequisite: Completion of 105 credit hours.*

COS 493 **1 hour**
Computer Science Senior Capstone
This course has two primary objectives: an oral examination and an off-campus study trip. The examination is prefaced by course reviews led by the students. The trip is used to strengthen interpersonal relationship skills and to examine topics critical to leading a balanced life. *Prerequisite: Completion of 105 credit hours.*

COS 494 **3 hours**
Senior Engineering Project II
The course is the second in a three course culminating experience preparing students for engineering practice through a major design and implementation project. *Prerequisite: COS 491. Offered January term.*

COS 495 **1 hour**
Senior Engineering Project III
The course is the third of a three course culminating experience preparing students for engineering practice through a major design and implementation project. *Prerequisite: COS 494. Offered spring semester.*

Systems Courses

SYS 101 **3 hours**
Introduction to Systems
An introduction to the general concept of systems defined as a combination of components acting together to perform a function. A variety of systems will be studied emphasizing control and feedback. Example systems might include manufacturing and distribution, power production, and satellite systems. Software systems and databases to support and control systems are emphasized. Field trips, guest lectures, and analysis of a major example system are utilized.

SYS 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

SYS 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

SYS 214 **3 hours**
Principles of Human Computer Interaction
This course discusses the analysis, design, development, and evaluation of interfaces allowing humans to interact with computers and the presentation of information in formats designed for human understanding. Topics include handheld, mobile, and ubiquitous device interfaces, as well as traditional desktop system GUIs. Prototyping and information visualization are also discussed.

SYS 310 **3 hours**
E-Commerce
Examines the development of and future prospects for electronic commerce. It focuses on the use of electronic transmissions to engage in exchange of products and services. Students will consider the emerging changes in business as well as the new opportunities for entrepreneurship brought on by e-commerce. They will explore the dynamics of technical innovations as well as the organizational and societal consequences of moving commerce electronically. They will also evaluate the operations of a variety of web-based businesses. Guest speakers from industry will lecture regarding the technical, economic, and political/regulatory aspects of e-commerce. *Prerequisites: SYS 101, COS 121 or 240.*

SYS 352 **3 hours**
Knowledge Based Systems
Prominent knowledge-based system approaches are introduced including crisp production rule systems and fuzzy logic systems. Principles of knowledge acquisition are taught and applied. Various forms of knowledge representation are experienced, including rules, nets, frames, and predicate logic. Programming is primarily in CLIPS. *Prerequisites: COS 121, SYS 101.*

SYS 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

SYS 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

SYS 390 **3 hours**
Information Systems Analysis
A study of the knowledge and skills needed to conduct the definition and analysis phases of an information system project. Central concepts are quality management and business process reengineering. Problem definition, information gathering, data and process modeling, and specification of logical system requirements using a business event methodology are emphasized. Learning is by doing: a major project is begun in this course and completed in SYS 394. *Prerequisites: Junior standing, COS 121 or 240; SYS 101.*

SYS 392 **1 hour**
Systems Seminar
This course provides a survey of systems topics with an emphasis on current development in many disciplines. Guest, faculty, and student presentations, plus occasional panel discussions, provide the format. May be taken twice. *Prerequisite: SYS 101.*

SYS 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

SYS 394 **3 hours**
Information Systems Design
A study of the knowledge and skills needed to conduct the design and construction phases of an information system project. Central concepts are: translating a logical design into a physical design, project management, and client-server architectures. Students will learn and use application technologies powering the World Wide Web. Learning is by doing: the major project defined and analyzed in SYS 390 will be designed and built. *Prerequisite: SYS 390.*

SYS 401 **4 hours**
Operations Research
Examination of mathematical techniques used in systems analysis, including mathematical programming, probability models, optimization, and statistical techniques, with an emphasis on applications using computer assisted instruction. *Prerequisites: The following courses (or their approved substitutes) must have been completed with a grade of C- or better: SYS 101, COS 121 or 240, MAT 210 or 352, MAT 146 or 151.*

SYS 402 **4 hours**
Modeling and Simulation
A study of mathematical modeling and simulation methods, focusing on discrete systems. A variety of simulation languages are reviewed, but Extend is used extensively. Many applications are surveyed and group term projects are carried out. *Prerequisites: The following courses (or their approved substitutes) must have been completed with a grade of C- or better: COS 121 or 240, MAT 210 and 382 or 352, MAT 146 or 151. (MAT 382 may be taken as a corequisite.)*

SYS 403 **3 hours**
Operations Management
This course presents the design (quality management, process design, and statistical process control) and operations (supply chain management, forecasting, inventory management, and resource planning) of productive systems. Quality, competitiveness in a global economy, and quantitative management are emphasized throughout the course. *Prerequisite: MAT 151.*

SYS 411 **3 hours**
Machine Learning
Classification learning systems of various types are explored. These include statistical pattern recognition, neural networks, genetic algorithms, and methods for inducing decision trees and production rules. Existing systems are reviewed. Group term projects allow development of and experimentation with a system of interest. *Prerequisite: COS 280.*

SYS 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

SYS 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

SYS 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.0 GPA in the major field.

Notes

Earth and Environmental Sciences

Chair, Professor P. Rothrock
Professors M. Guebert, R. Squiers
Associate Professor R. Reber

The department of earth and environmental sciences is housed in the Randall Environmental Center, located on 145 acres of preserved natural area of the Upland campus. The environmental science program offers students the opportunity to enhance their liberal arts education with a cluster of specialized courses designed to provide the knowledge, skills and conscience necessary for environmental decision-making for stewardship and service in a complex world. Courses focusing on practical problem-solving methodologies add depth, utility and perspective to a variety of fields of study. The department offers opportunities for applied study in international settings, and a summer field course in the Black Hills of South Dakota. Student research is strongly encouraged and has been supported by external funding.

The department offers a bachelor of science degree in environmental science and coordinates three integrated majors: chemistry–environmental science (see listing under chemistry department), mathematics–environmental science (see listing under mathematics department) and environmental engineering (see listing under physics department). These majors provide excellent preparation for graduate education or job placement in a wide variety of career fields in environmental science. In addition to preparation for the Graduate Record Exams (GRE), these programs also serve as excellent preparation for the LSAT (law school entrance exam) and GMAT (MBA entrance exam).

Students in a wide range of majors outside the department may choose to develop a variety of practical scientific skills and explore the concepts of environmental stewardship by selecting one of three minors in the department: environmental science, environmental studies, and environmental law and policy.

In addition to the programs described below, a master of environmental science degree is offered. Qualified Taylor University students may participate in an accelerated 4+1 option, thus earning both the bachelor and master degrees in five years. Visit http://www.taylor.edu/mes, contact the MES program director, or call the department of earth and environmental sciences for more information.

Environmental Science (BS)

The bachelor of science degree with a major in environmental science requires 67-71 hours.

Major Requirements

BIO 304	4	Field Natural History of the Black Hills
ENS 204	4	Principles of Ecology
ENS 231	4	Introduction to Environmental Science
ENS 383	4	Environmental Ethics
ENS 402	4	Environmental Law and Policy
ENS 393	2	Practicum
MAT 210	4	Introductory Statistics
POS 331	3	Public Policy

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Biology Requirements

Select one of the following courses:

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology

Select two of the following courses:

BIO 301	4	Taxonomy of Vascular Plants
BIO 307	4	Vertebrate Natural History
BIO 441	4	Environmental Physiology
BIO 471	4	Microbiology and Immunology
ENS 475	4	Systems Ecology

Earth and Physical Science Requirements

ENS 241	4	Physical Geology

Select two of the following courses:

ENS 355	4	Geospatial Analysis
ENS 361	4	Geomorphology
ENS 362	4	Hydrogeology
ENS 363	4	Applied Geology and Environmental Planning
ENS 364	4	Water Resources and Appropriate Technology
†CHE 320	3	Environmental Chemistry
and		
†CHE 320L	1	Environmental Chemistry Lab

†CHE 320 & 320L count as one course.

Electives

Select one of the following options:

Option 1 (Biology)

Select two courses not previously used from the following:

BIO 101	4	Principles of Cell Biology
BIO 103	3	Introductory Plant Biology
BIO 104	3	Introductory Animal Biology
BIO 244	4	Human Anatomy and Physiology I
BIO 245	4	Human Anatomy and Physiology II
BIO 301	4	Taxonomy of Vascular Plants
BIO 307	4	Vertebrate Natural History
BIO 331	4	Comparative Anatomy
BIO 452	4	Animal Physiology
BIO 471	4	Microbiology and Immunology
ENS 475	4	Systems Ecology

Option 2 (Earth and Physical Science)

Select two courses not previously used from the following:

ENS 340	4	Global Ecology/Global Issues
ENS 341	4	Earth Materials
ENS 355	4	Geospatial Analysis
ENS 361	4	Geomorphology
ENS 362	4	Hydrogeology
ENS 363	4	Applied Geology and Environmental Planning
ENS 364	4	Water Resources and Appropriate Technology

Environmental Science Minor

The minor in environmental science requires 19-20 hours and is designed for students in science majors; minor not open to environmental science majors. Students who desire entry into the Master of Environmental Science program should also take ENS 204, MAT 210, and CHE 201 and 202 or CHE 211 and 212.

Minor Requirements

Select one course from the following:

ENS 200	3	Environment and Society
ENS 231	4	Introduction to Environmental Science

Select one course from the following:

ENS 383	4	Environmental Ethics
ENS 402	4	Environmental Law and Policy

Select 12 hours from:

ENS 204	4	Principles of Ecology
ENS 241	4	Physical Geology
ENS 340	4	Global Ecology/Global Issues
ENS 341	4	Earth Materials
ENS 355	4	Geospatial Analysis
ENS 361	4	Geomorphology
ENS 362	4	Hydrogeology
ENS 363	4	Applied Geology and Environmental Planning
ENS 364	4	Water Resources and Appropriate Technology
ENS 475	4	Systems Ecology
BIO 304	4	Field Natural History of the Black Hills
CHE 320	3	Environmental Chemistry
and		
CHE 320L	1	Environmental Chemistry Lab

Appropriate course substitutions may be made with permission of the department chair.

Environmental Law and Policy Minor

The minor in environmental law and policy requires 17-19 hours and is especially appropriate for students with majors in political science and those pursuing careers in law; minor not open to environmental science majors.

Minor Requirements

ENS 383	4	Environmental Ethics
ENS 402	4	Environmental Law and Policy
POS 331	3	Public Policy

Select one course from the following:

ENS 200	3	Environment and Society
ENS 231	4	Introduction to Environmental Science (*recommended)*

Select one course from the following:

GEO 240	3	Introduction to Geology
ENS 241	4	Physical Geology

Environmental Studies Minor

This minor in environmental studies requires 17-19 hours and is especially appropriate for students with majors in business, communication arts, humanities, or social sciences. It should be of particular interest for students pursuing a semester abroad.

Minor Requirements

ENS 383	4	Environmental Ethics

Select one course from the following:

ENS 200	3	Environment and Society
ENS 231	4	Introduction to Environmental Science (*recommended.)*

Select one course from the following:

GEO 240	3	Introduction to Geology
ENS 241	4	Physical Geology

Select 7-8 hours from:

ENS 204	4	Principles of Ecology
ENS 304	4	Global Ecology/Global Issues
ENS 341	4	Earth Materials
ENS 355	4	Geospatial Analysis
ENS 361	4	Geomorphology
ENS 362	4	Hydrogeology
ENS 363	4	Applied Geology and Environmental Planning
ENS 364	4	Water Resources and Appropriate Technology
ENS 402	4	Environmental Law and Policy
ENS 475	4	Systems Ecology
ECO 315	3	Environmental and Natural Resource Economics

Appropriate course substitutions may be made with permission of the chair of the department.

Environmental Science Courses

ENS 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENS 200 **3 hours**
Environment and Society
Introduction to ecological principles and human impacts on the environment. Issues studied include population dynamics, natural resources, pollution problems, and environmental ethics. Lab exercises focus on experimental ecology and the basic techniques used to describe and measure environmental quality. *Meets the general education life science requirement. Environmental science majors should elect ENS 231 rather than ENS 200.*

ENS 201 **4 hours**
Introduction to Geology in the Field
Introduction to earth's materials, processes, and history as discovered through field observations of minerals, rocks, fossils, strata, caves, rivers, canyons, and mountains. Emphasis is placed on field experiences and observations, complemented by study of maps, laboratory work, and discussions. *Offered during summer at the Black Hills Science Station near Rapid City, South Dakota.*

ENS 204 **4 hours**
Principles of Ecology
A majors core course: An introduction to the relationships existing between organisms and their environment. Lectures focus on the structural and functional aspects of populations, communities, and ecosystems in the context of the major North American biomes. Three hours lecture and two hours laboratory per week. *Does not normally satisfy general education science requirement. Prerequisite: Three hours of BIO or ENS or permission of the instructor.*

ENS 231 **4 hours**
Introduction to Environmental Science
An introduction to environmental science, including a discussion of ecological principles and their application, energy systems, pollution problems, environmental policy and decision making, and the scientific and ethical implications of human impacts on the environment. Lab exercises focus on experimental ecology and the basic techniques used to describe and measure environmental quality. This course serves three functions: (1) it is the entry level course for environmental science majors; (2) it may be taken for general education lab science credit; and (3) biology majors may count it as a 200-level biology course when calculating course hour requirements in biology. Three hours of lecture and two hours of lab per week. *Meets the general education life science requirement.*

ENS 241 **4 hours**
Physical Geology
A general introduction to the earth's internal and external physical, dynamic systems. Topics include occurrence and formation of minerals and rocks, processes that shape the earth's surface, and the internal structure and dynamics that lead to plate tectonics and crustal deformation. Special emphasis is placed on the environmental aspects of humans' interaction with the earth. Three hours of lecture and two hours of lab per week. *Meets general education earth science requirement.*

ENS 242 **4 hours**
Geology of Indiana
An introduction to the concepts of physical and historical geology in the context of Indiana. Topics include rocks, fossils, structure, landforms, and earth and environmental resources of the state. Offered during summer session and includes a required field trip to several regions of Indiana for field observation and collection of mineral, rock, and fossil specimens. *Meets general education earth science requirement.*

ENS 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENS 340 **4 hours**
Global Ecology/Global Issues
An introduction to the analysis of complex issues. Global actors, their values and policies, and the potential futures they create are investigated in the context of issues such as economic development, energy, food, and population. Global interdependence is stressed. The academic perspective is interdisciplinary, and the geographic focus is non-North American. Three hours of lecture and two hour discussion section per week. *Prerequisite: ENS 200 or 231.*

ENS 341 **4 hours**
Earth Materials
Basic principles of mineralogy and petrology, with emphasis placed on description, identification, classification, and interpretation of rock-forming minerals and the igneous, sedimentary, and metamorphic rocks they comprise. Also includes origin and occurrence of earth materials and their uses in economic and environmental contexts. Lab emphasizes observation of hand specimens and some thin-sections. Three hours of lecture and the equivalent of two hours of lab per week, including field trips to selected locations throughout the state. *Prerequisite: ENS 241 or permission from the instructor.*

ENS 355 **4 hours**
Geospatial Analysis
An introduction to methods of collection, management and analysis of geospatial data. Topics include basic map properties, preparation and interpretation of thematic and topographic maps, analysis of aerial photographs, surveying by traditional and global positioning systems (GPS) techniques, and acquisition of remotely-sensed satellite data. Special emphasis is placed on methods and applications of geographic information systems (GIS) in geospatial analysis. *Prerequisite: ENS 200, 231, or 241.*

ENS 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

ENS 361 **4 hours**
Geomorphology
An applied approach to the study of earth surface processes and the landforms they produce. Topics include processes and landforms associated with weathering, mass wasting, rivers, karst, tectonics, glaciers, shorelines, and wind. Emphasis placed on environmental and land-use applications. Field and lab assignments include qualitative descriptions and quantitative measurements from fieldwork, topographic and geologic maps, and aerial photographs. Three hours of lecture and three hours of lab per week. *Prerequisite: ENS 241 or permission from the instructor.*

ENS 362 **4 hours**
Hydrogeology
Basic processes and measurement of the hydrologic cycle, including precipitation, evaporation, surface runoff, stream flow, soil moisture, and groundwater. Emphasis placed on groundwater, including aquifer characteristics, principles of flow, conceptual models of regional flow, geology of occurrence, well hydraulics, chemistry and quality, detection of pollutants, contaminant transport and remediation, and resource development. Three hours of lecture and three hours of lab per week. *Prerequisites: ENS 241 or permission from the instructor.*

ENS 363 **4 hours**
Applied Geology and Environmental Planning
The application of principles from surficial geology and hydrology in the recognition, assessment, and mapping of environmental geo-hazards in the context of environmental planning. Topics include hazards and land-use analysis of soils, slopes, floods, groundwater, coasts, and tectonic activities. Three hours of lecture and three hours of lab per week. *Prerequisite: ENS 241 or permission from the instructor.*

ENS 364 **4 hours**
Water Resources and Appropriate Technology
Concepts and practices of water resource development and appropriate technology in the context of environmental resources in a developing country. Students participate in a service-learning project of design and implementation of water resource related appropriate technology (such as well-drilling, water quality protection, hygiene training, and sanitation system design) as part of a holistic ministry toward transformational development. Students develop a perspective on the role of appropriate technology in the responsibility of individuals in cross-cultural service, in issues of cross-cultural communication and interactions, and in God's purposes in missions and the worldwide church. *Prerequisite: IAS 120.*

ENS 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENS 383 **4 hours**
Environmental Ethics
An in-depth discussion of the ethical implications of major environmental problems, such as world population and food supply, inequities in land and resource distribution, animal rights, materialism and personal life styles, and exploitation vs. stewardship of the environment. Three hours of lecture and a discussion section per week. *Prerequisite: Junior/senior ENS majors or permission from the instructor.*

ENS 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

ENS 402 **4 hours**
Environmental Law and Policy
Lectures introduce the major elements of U.S. environmental law: NEPA, EIS, CAA, CWA, RCRA, CERCLA, TSCA, FIFRA and CRTK. The administrative process, cost/benefit analysis and the role of litigation in enforcement are also discussed. Presentation techniques and debate skills are introduced. Three hours of lecture and a discussion section per week. *Prerequisite: Senior environmental science majors and minors or permission from the instructor.*

ENS 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

ENS 475 **4 hours**
Systems Ecology
The principles of systems theory are introduced in an integrated study of the development, dynamics, and disruption of natural ecosystems. Theoretical, analytical, and experimental aspects of ecosystems are explored. Students are introduced to the use of microcomputers as a tool in ecosystem modeling. *Prerequisites: ENS 204 and one course in college-level mathematics or computer science.*

ENS 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

ENS 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

Notes

Mathematics

Chair, Professor M. Colgan
Professors R. Benbow, J. Case, K. Constantine, M. DeLong
Assistant Professors P. Mummert, D. Toll

The major purposes of the mathematics department are to help students increase their knowledge and understanding of mathematical concepts, develop their reasoning ability and problem-solving skills, and improve their ability to apply mathematics in a variety of areas. The department prepares students to become teachers of mathematics; to enter careers in business, industry, and government; and to pursue graduate study in mathematics and related areas.

The student expecting to major in mathematics should have four years of high school mathematics, including two years of high school algebra, geometry, trigonometry and calculus. In the freshman year, students planning to major in mathematics and those preparing for scientific work, including engineering, should be qualified to begin with MAT 151 or MAT 230.

The department offers four majors: mathematics, mathematics/systems, mathematics education, and mathematics–interdisciplinary.

Each year the mathematics department offers at least four sanctioned events such as special lectures or colloquiums. All majors are required to attend a total of at least 12 sanctioned events before taking the MAT 493 course.

Mathematics (BA)

Designed for students planning to attend graduate school, the bachelor of arts degree with a major in mathematics requires two years of sequential college-level study in one foreign language and at least 46-49 major hours.

Major Requirements

MAT 180	3	Problem Solving
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 255	3	Justifications in Mathematics
MAT 340	4	Advanced Calculus
MAT 352	4	Mathematical Statistics
MAT 392	1	Mathematics Seminar
MAT 455	3	Abstract Algebra
MAT 461	3	Real Analysis
MAT 493	3	Senior Capstone

Select one course from the following:

MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis
MAT 330	3	Technology for Mathematics
MAT 382	3	Advanced Statistical Methods
MAT 385	3	Mathematics of Finance

Electives

Select three hours of mathematics electives—MAT 215 or higher.

Additional Major Requirements

Select one course in chemistry or physics from:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Mathematics/Systems (BS)

The bachelor of science degree with a major in mathematics/systems requires a minimum of 47 hours (42 math hours) in the major and curriculum requirements in systems analysis. *All systems curriculum courses must be completed with a grade of C- or better.*

Major Requirements

MAT 180	3	Problem Solving
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 255	3	Justifications in Mathematics
MAT 340	4	Advanced Calculus
MAT 352	4	Mathematical Statistics
MAT 382	3	Advanced Statistical Methods
MAT 392	1	Mathematics Seminar
MAT 393	3-4	Practicum
MAT 455	3	Abstract Algebra
MAT 493	3	Senior Capstone

Additional Major Requirements

Select one course in chemistry or physics from:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Electives

Select three hours of mathematics electives—MAT 215 or higher.

Systems Curriculum Requirements

COS 120	4	Introduction to Computer Science I
COS 121	4	Introduction to Computer Science II
IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 352	4	Mathematical Statistics
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
SYS 394	3	Information Systems Design
MAT 393	3-4	Practicum

Select one course from the following:

*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation

Systems Electives

Select at least three hours of electives in addition to those required in the major or systems.

COS 265	3	Data Structures and Algorithms
COS 382	3	Language Structures
MAT 251	4	Differential Equations
SYS 214	3	Principles of Human Computer Interaction
SYS 310	3	E-Commerce
*SYS 401	4	Operations Research
*SYS 402	4	Modeling and Simulation
SYS 403	3	Operations Management

**Courses in both areas may count only once.*

Mathematics Education (BS)

The bachelor of science degree in mathematics education requires 74-82 hours of professional education and major courses (50 hours of math). *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 310	2	Discipline and Classroom Management
*EDU 332	3	The Junior High/Middle School
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
*MAT 280	3	Mathematics in the Junior High/Middle School
MAT 309	2	Teaching Math in Secondary, Junior High/Middle Schools
SED 320	3	Exceptional Children

**For those seeking junior high and middle school education licensure, EDU 332 and MAT 280 are required.*

Mathematics Requirements

MAT 180	3	Problem Solving
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 255	3	Justifications in Mathematics
MAT 312	4	College Geometry
MAT 340	4	Advanced Calculus
MAT 352	4	Mathematical Statistics
MAT 392	1	Mathematics Seminar
MAT 455	3	Abstract Algebra
MAT 493	3	Senior Capstone

Additional Major Requirements

Select <u>one</u> course from the following:

COS 120	4	Introduction to Computer Science I
MAT 251	4	Differential Equations
MAT 310	3	Mathematical Modeling with Numerical Analysis
MAT 330	3	Technology for Mathematics
MAT 370	3	Selected Topics *(topic must be approved by department)*
MAT 385	3	Mathematics of Finance
PHY 341	3	Math Methods in Physics and Engineering

Select <u>six</u> hours of mathematics electives—MAT 215 or higher.

Select <u>one</u> of the following chemistry or physics courses:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Mathematics—Interdisciplinary (BS)

The bachelor of science degree with a major in mathematics-interdisciplinary requires a minimum of 52-56 hours and the completion of a minor (or major) in accounting, biology, chemistry, computer engineering, environmental science, engineering physics, computer science, economics, finance or physics. Minor (or major) requirements are listed under the department offering the minor. The practicum may be in a supporting area (major or minor) instead of mathematics.

Major Requirements

MAT 180	3	Problem Solving
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
MAT 255	3	Justifications in Mathematics
MAT 310	3	Mathematical Modeling with Numerical Analysis
MAT 352	4	Mathematical Statistics
MAT 382	3	Advanced Statistical Methods
MAT 392	1	Mathematics Seminar
MAT 393	2-4	Practicum
MAT 493	3	Senior Capstone

Select <u>one</u> course from the following:

MAT 340	4	Advanced Calculus
MAT 455	3	Abstract Algebra

Additional Major Requirements

COS 120	4	Introduction to Computer Science I

Electives

Select <u>three</u> hours of mathematics electives—MAT 215 or higher.

Select <u>one</u> of the following chemistry or physics courses:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Mathematics Minor

A mathematics minor requires a minimum of 23-25 hours.

Minor Requirements

MAT 230	4	Calculus II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option

Select an additional <u>15</u> hours of mathematics elective hours above MAT 151. MAT 201 and 202 do not count toward the minor.

Mathematics Courses

MAT 100 1 hour
Mathematics Fundamentals
A study of the basic arithmetic operations, exponents, ratios, linear and quadratic equations, graphs, and story problems. This course is specifically designed to assist those students who need help for the mathematics proficiency examination. *Pass-fail only. Does not count toward a mathematics major or minor.*

MAT 110 3 hours
Finite Mathematics
A study of selected topics from set theory, matrices, systems of linear equations and inequalities, linear programming, counting and probability, statistics, and mathematics of finance. *Prerequisite: A good understanding of algebra. Does not count toward a mathematics major or minor. Meets general education mathematics requirement.*

MAT 120 3 hours
Investigations in Mathematics
A course designed to engage students in relevant college-level mathematics and its connection to the Christian faith and everyday life. Students will experience interesting questions and real-life applications of mathematics from a variety of contexts while using appropriate technology. Emphasis will be on thinking, reasoning, and exploring patterns as well as communicating mathematical ideas. Topics will be chosen from data analysis, modeling, probability, statistics, mathematics of finance, logic, infinity, geometric applications, and fundamentals of problem solving. *Does not count toward a mathematics major or minor. Meets general education mathematics requirement.*

MAT 140 3 hours
Fundamental Calculus for Applications
An introductory study of derivatives, series, and integrals with a wide range of applications, including maximum and minimum problems. *Prerequisite: A good understanding of algebra. Does not count toward a mathematics major or minor. Meets general education mathematics requirement.*

MAT 145 3 hours
Introduction to Functions and Calculus
The MAT 145/146 sequence aims to provide a deep understanding of topics from precalculus and calculus as well as a strong sense of their usefulness. Fundamental ideas of calculus, specifically rates of change, are introduced early and used to provide a framework for the study of mathematical modeling involving algebraic, exponential, and logarithmic functions. Applications to business, economics, and science are emphasized. *Meets general education mathematics requirement. MAT 145/146 may be taken as a two-semester substitute for MAT 151.*

MAT 146 3 hours
Functions and Calculus
MAT 146 is the second of a two-course sequence which begins with MAT 145, and continues the investigation of functions, including trigonometric functions, and their rate of change. Students are introduced to integrals and methods of integrations with applications. Further topics, such as infinite series and differential equations are included. *Prerequisite: MAT 145. MAT 145/146 may be taken as a two-semester substitute for MAT 151.*

MAT 151 4 hours
Calculus I
A study of functions, including algebraic and trigonometric functions. An introduction to the algebraic, numerical, and graphical approaches to calculus, including limits, continuity, derivatives, integrals, and applications. *Prerequisite: A good understanding of algebra and trigonometry. Meets general education mathematics requirement. MAT 145/146 may be taken as a two-semester substitute for MAT 151.*

MAT 170 1-4 hours
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

MAT 180 3 hours
Problem Solving
An introduction to the mathematical sciences through the study of problem solving. An overview of various methods of problem solving to discover patterns, construct and modify conjectures and develop proofs of those conjectures. There will be an emphasis on developing creativity, confidence, and concentration. Content areas studied will include algebra, combinatorics, number theory and calculus, all from a problem-solving point of view. *Prerequisite: MAT 151 or one semester of high school calculus. Meets general education mathematics requirement.*

MAT 201 4 hours
Mathematics for Elementary Teachers I
First of a two-course integrated content-methods sequence for elementary teacher preparation. This course is a study of number systems, operations, and data analysis/probability, with special reference to teaching materials, laboratory methods, and pedagogy, including classroom use of manipulatives and technology. Each student is required to work with a MAT 202 student in a teaching team in the Taylor-Eastbrook Mathematics Project (TEMP). *Does not count toward a mathematics major or minor. Open to majors in early childhood and elementary education. Eight hours of MAT 201 and 202 meet the general education mathematics requirement.*

MAT 202 4 hours
Mathematics for Elementary Teachers II
The second of a two-course integrated content-methods sequence for elementary teacher preparation. Course topics emphasize the standards of geometry, measurement, problem-solving, communication, and reasoning. Each student is responsible each week for planning, teaching, and evaluating a mathematics lesson in a local school (TEMP). *Prerequisite: MAT 201. Does not count toward a mathematics major or minor. Open to majors in early childhood and elementary education. Eight hours of MAT 201 and 202 meet the general education mathematics requirement.*

MAT 210 4 hours
Introductory Statistics
A study of basic statistical methods with a focus on applied data analysis in a group setting using statistical software. Develops proficiency in the use of descriptive methods, sampling, linear regression and correlation, probability theory and distributions, statistical inference techniques for estimation and hypothesis testing and experimental design. *Meets general education mathematics requirement.*

MAT 215 3 hours
Discrete Mathematics for Computer Science
Discrete mathematics concepts are studied that are foundational for further study in computer science. Topics include propositional logic and quantifiers, proofs with emphasis on induction, design and optimization of combinatorial circuits, Boolean algebra, solution of certain classes of recurrence and equivalence relations and modulo arithmetic with application to RSA cryptography. *Prerequisites: COS 120, MAT 146 or 151 or equivalent.*

MAT 220 4 hours
Ways of Knowing
Topics studied include number, logic, Euclidean and non-Euclidean geometry, algebraic structures, dimension, and infinity. A study is made of the deductive method in mathematics and its relationship to ways of knowing in other areas. There is an emphasis on the beauty of mathematics and the relationship of mathematics to science and other forms of culture including the arts and religion. *Course is offered within the honors program. Meets general education mathematics requirement.*

MAT 230 4 hours
Calculus II
A study of analytic geometry, functions, limits and derivatives, differentiation and integration of algebraic functions and elementary transcendental functions, applications of the derivative, the definite integral, sequences, series, Taylor's formula, and special techniques of integration. *Prerequisite: MAT 146 or 151 or equivalent.*

MAT 240 **4 hours**
Calculus III
A study of parametric equations, polar coordinates, vectors, three-dimensional geometry, partial derivatives, multiple integration, and vector analysis. *Prerequisite: MAT 230 or equivalent. Offered fall semester.*

MAT 245 **4 hours**
Linear Algebra
A course on matrix theory, linear equations and linear dependence, vector spaces and linear transformations, characteristic equation, quadratic forms, and the singular value decomposition. *Prerequisite: MAT 240. Offered spring semester of even years.*

MAT 251 **4 hours**
Differential Equations
A course on the solution of differential equations of the first order and first degree, linear differential equations with constant coefficients, nonhomogeneous equations by undetermined coefficients and variation of parameters, systems of differential equations, nonlinear differential equations, and an introduction to series solutions. Numerical methods and qualitative analysis are also used. Differential equations are used to model physical problems, including vibration problems and electrical circuits. *Prerequisite: MAT 240. Offered spring semester.*

MAT 255 **3 hours**
Justifications in Mathematics
The focus of the course is for students to acquire the ability to create and express mathematical arguments through the exploration of mathematical ideas. In addition to gaining an understanding and appreciation for interesting mathematics, students will develop an ability to think creatively, to analyze critically, and to communicate appropriately mathematical reasoning and argumentation. Topics include proof techniques, logic, sets, functions, number theory, infinity, and graph theory. *Prerequisite: MAT 151 or equivalent. Offered fall semester.*

MAT 261 **1 hour**
Special Problems
Selected topics in mathematics. *Prerequisite: Consent of the department chair.*

MAT 262 **1 hour**
Special Problems-TEMP
Selected topics in mathematics.

MAT 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

MAT 280 **3 hours**
Mathematics in the Junior High/Middle School
An integrated content-methods course for middle school and introductory high school preparation. This course includes the mathematical strands of reasoning and algebra, rational numbers, geometry/measurement, and data analysis and probability, interwoven with the connections to appropriate pedagogical strategies for middle grades' teaching and learning. Includes a field-based teaching lab. *Math majors only or permission of the instructor.*

MAT 309 **2 hours**
Teaching Math in Secondary, Junior High/Middle Schools
This course is designed to assist teacher candidates in developing their pedagogical content knowledge in the area of mathematics. It addresses such topics as lesson planning, higher-order thinking, professional development, content-appropriate teaching strategies, standards-based instruction, assessment of student learning, educational technology, motivational techniques, and instructional resources. National and state math standards are examined as a basis for reflective teaching and best practices. This junior-level course should be taken the spring semester before student teaching. *Prerequisites: EDU 150, 260 and approval into the Teacher Education Program. Corequisite: EDU 309.*

MAT 310 **3 hours**
Mathematical Modeling with Numerical Analysis
An introduction to modeling and the methods, techniques, and pitfalls in scientific computing and numerical analysis. The course will emphasize projects, writing, technology, and applications. Topics include iterative and algorithmic processes, error analysis, numerical integration and differentiation, curve fitting, and numerical solutions to different equations. *Required for mathematics majors with a concentration in computer science and for computer science majors with a concentration in scientific computing. Fulfills elective requirements in the systems curriculum and for majors in mathematics in environmental science and mathematics in secondary education. Prerequisites: COS 120, MAT 240. Offered fall semester of even years.*

MAT 312 **4 hours**
College Geometry
Advanced Euclidean plane geometry with a brief survey of some of the non-Euclidean geometries and vector and transformational geometry. *Prerequisites: MAT 180 or 245. Offered spring semester of odd years.*

MAT 330 **3 hours**
Technology for Mathematics
A study of the use of software and graphing calculators in mathematics. Technological tools are used to explore various topics in mathematics including precalculus, business mathematics, probability and statistics, calculus, and linear algebra. *Prerequisites: MAT 180 and 240.*

MAT 340 **4 hours**
Advanced Calculus
An introduction to a rigorous development of the fundamental concepts of calculus. The real number system, sequences, series, limits, differentiation, and integration are developed rigorously. *Prerequisites: MAT 240; MAT 180 or 215. Offered spring semester of even years.*

MAT 352 **4 hours**
Mathematical Statistics
A theoretical, as well as applied, study of counting outcomes, probability, probability distributions, sampling distributions, confidence intervals, tests of hypotheses, linear regression, and correlation. *Corequisite: MAT 240. Offered fall semester.*

MAT 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

MAT 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

MAT 382 **3 hours**
Advanced Statistical Methods
Introduction to a variety of topics including nonparametric statistical methods and linear models, with simple linear regression, multiple regression, and analysis of variance as special cases of the linear model. The emphasis will be on translating applied questions into an appropriate statistical model, checking model assumptions, and interpreting analyses in applied contexts. *Prerequisites: MAT 210 or 352; and MAT 146 or 151.*

MAT 385 **3 hours**
Mathematics of Finance
This course is an introduction to the mathematical models used in finance and economics with particular emphasis on models for pricing derivative instruments such as options and futures. The goal is to understand how the models derive from basic principles of economics, and to provide the necessary mathematical tools for their analysis. A solid background in basic probability theory is necessary. Topics include risk and return theory, portfolio theory, capital asset pricing model, random walk model, stochastic processes, Black-Scholes Analysis, numerical methods and interest rate models. *Prerequisite: MAT 210 and MAT 230, or MAT 352 or permission of instructor. Offered fall semester of odd years.*

MAT 392 **1 hour**
Mathematics Seminar
Each student in the seminar researches a mathematical topic and makes a presentation to the entire group. *Prerequisite: MAT 240. Offered fall semester.*

MAT 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during the summer.*

MAT 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

MAT 455 **3 hours**
Abstract Algebra
The development of the postulates of group theory, rings, integral domains, and fields. Applications to cryptography. *Prerequisites: MAT 180 and 240. Offered spring semester of odd years.*

MAT 456 **3 hours**
Advanced Algebra
A continued study of Abstract and Linear Algebra. Topics include Galois Theory, cryptography, and field extensions. *Prerequisite: MAT 455.*

MAT 461 **3 hours**
Real Analysis
An advanced study of the real number system, topology, functions, sequences, limits, continuity, and the theory of differentiation and integration. *Prerequisite: MAT 340. Offered spring semester of odd years.*

MAT 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

MAT 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with a minimum GPA of 3.00 in the major field.

MAT 493 **3 hours**
Senior Capstone
An overview of mathematics with an emphasis on the integration of all areas in undergraduate mathematics with an exploration of the relationship between mathematics and the Christian faith. Open to senior status mathematics majors only. Offered during January interterm.

Notes

Natural Science

The natural science area includes curricular offerings in biology, chemistry, computer science and engineering, mathematics, and physics and engineering for the major in natural science.

Pre-Medical Technology Concentration (3-1 Program)

Advisor, Professor D. Hammond

A major in natural science with a pre-professional concentration in pre-medical technology is designed for students participating in 3-year pre-professional programs. Upon completion of three years at Taylor University, students then complete 1-2 years of professional requirements at an approved accredited school. Upon receipt of an official transcript verifying the satisfactory completion of one year at an approved accredited school, the student is granted the baccalaureate degree by Taylor University.

All Taylor University degree requirements are applicable with the following exceptions: PHI 413, the minimum of 42 hours of upper-division credit, the minimum 128 total-hour requirement, and the senior comprehensive examination. Normally, students complete all applicable requirements within three years, including a minimum of 96 total hours and a minimum of 40 major hours taken in courses offered in the natural science area. These courses must be selected in accordance with the unique requirements of the pre-professional program.

The medical technologist serves as a vital part of the hospital medical team, performing the lab tests that lead to successful diagnosis of illness. Taylor University maintains affiliations with ; Methodist Hospital of Indiana, Indianapolis, Indiana.

The National Accrediting Agency for Clinical Lab Sciences requires three years of college work as a minimum of pre-professional preparation. After satisfactory performance of preparatory courses specified by the hospital program of choice (usually an additional year or more), a baccalaureate degree will be granted by Taylor University. The student is then eligible to take a national certifying examination. Upon successfully passing the certification examination, he/she will be certified as a registered medical technologist or its equivalent.

Natural Science—Pre-Medical Technology Concentration (BS)

The bachelor of science degree with a major in natural science and a pre-medical technology concentration requires 40 hours of natural science with a minimum of 15 hours in biology and 15 hours in chemistry.

All Taylor University degree requirements are applicable with the following exceptions: PHI 413; the minimum of 42 hours of upper-division credit; the minimum 128 total-hour requirement; and the senior comprehensive exam. Students must complete a minimum of 96 total hours at Taylor prior to entering the hospital program.

Major Requirements

Select at least 15 hours of biology:

BIO 101	4	Principles of Cell Biology
BIO 203	4	Principles of Genetics
BIO 244	4	Human Anatomy and Physiology I
BIO 245	4	Human Anatomy and Physiology II
BIO 471	4	Microbiology and Immunology

Select at least 15 hours of chemistry:

*CHE 201	4	General Chemistry I
*CHE 202	4	General Chemistry II
*CHE 211	4	College Chemistry I
*CHE 212	4	College Chemistry II
CHE 301	3	Analytical Chemistry I
CHE 301L	1	Analytical Chemistry I Lab
CHE 302	3	Analytical Chemistry II
CHE 302L	1	Analytical Chemistry II Lab
CHE 311	4	Organic Chemistry I

**CHE 211/212 is the preferred combination; may not complete both CHE 201/202 and CHE 211/212*

Select one option from the following:

MAT 140	3	Fundamental Calculus for Applications
MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Some hospital programs also require at least one semester of physics.

Science Research Training Program

The purpose of the Science Research Training Program is to stimulate students beyond "normal education" with hands-on practical experiences, promote real-world industrial relationships (careers), and prepare future graduate students. As faculty, students and staff, our goal is to pursue excellence (world leadership in selected research areas) and thereby stay on the cutting edge of scientific research and thought.

We encourage scholarly research and crossover interactions between various disciplines, and we promote publications in professional journals by Taylor University faculty and students. Where possible, we relate science with society and apply science and technology to various mission field needs. Research activities are carried on quietly and often on a long-range basis, but are essential to leadership and progress. During the summer months, when faculty and students can devote more time to independent research, student stipends are available for research one-on-one with a faculty member. These projects include the areas of biology, chemistry, computers, engineering, environmental science, math, and physics.

Natural Science Courses

NAS 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

NAS 220 **4 hours**
Natural Science Research Methods
To introduce general science research in the fields of biology, chemistry, computer science, environmental science, mathematics, and physics/engineering. An overview of selected representative research topics, problem solving approaches, instrumentation, and analysis techniques. The lab emphasizes the use of scientific instrumentation and advanced computer software tools. *For students enrolled in the Summer Honors program. Meets any general education lab science requirement.*

NAS 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

NAS 309 **2 hours**
Science Education Methods
This is a junior-level science education methods course for biology, chemistry, and physics majors obtaining certification in secondary education. This course covers the philosophy of science, science educational psychology, the science standards (both national and state), science curriculum development, classroom management and assessment, laboratory management and development, and technology and professional development in the sciences. *Prerequisite: EDU 150, 260 and approval into the teacher education program is required. Corequisite: EDU 309.*

NAS 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

NAS 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

NAS 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

NAS 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

NAS 480 **1 hour**
Natural Science Seminar
The integration of topics from contemporary science with an emphasis on recent research reports of interdisciplinary interest. Guest lecturers and faculty and student reports serve as the method of instruction.

NAS 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

Notes

Physics and Engineering

Chair, Professor K. Kiers
Professors R. Davis, H. Voss
Associate Professor D. Boyajian
Assistant Professors J. Gegner, J. Huang

The purpose of the physics and engineering department is to provide an educational experience within a Christian context that equips students with the ability to obtain knowledge and understanding about the physical world for use in research, graduate studies and careers and to positively impact society. The physics and engineering department offers instruction in physics, engineering, astronomy, and physical science. Space physics, experimental condensed matter physics, theoretical high-energy physics, acoustics, advanced engineering instrumentation, power electronics and microelectronics provide the major research interests in the department.

Departmental majors include: physics, physics/systems, engineering physics, environmental engineering, physics science education, physical science education/physics concentration and physics/mathematics education.

Physics (BA)

The bachelor of arts degree with a major in physics requires two years of one foreign language and 76-82 hours in the major.

Major Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
PHY 321	3	Electricity and Magnetism
PHY 322	3	Waves and Physical Optics
PHY 330	2	Advanced Lab
PHY 341	3	Math Methods in Physics and Engineering
PHY 342	3	Analytical Mechanics
PHY 350	4	Thermodynamics and Statistical Mechanics
PHY 412	3	Quantum Mechanics
PHY 493	3	Physics Senior Capstone

Electives

Select 10 hours of physics and engineering elective courses from:

ENP 252	4	Principles of Engineering
ENP 301	3	Statics and Dynamics
ENP 321	2	Applied Electromagnetics
ENP 331	4	Introduction to Electronics
ENP 332	4	Control Systems
ENP 341	4	Microcomputer Interfacing
ENP 351	3	Thermodynamics
ENP 352	3	Materials Science and Solid State Physics
ENP 355	3	Fluid Mechanics and Water Flow
ENP 370	1-4	Selected Topics
ENP 431	4	Advanced Electronics and Microcircuits
PHY 201	4	Introductory Astronomy
PHY 313	2	Nuclear Radiation Experimental Methods
PHY 370	1-4	Selected Topics
PHY 413	2	Quantum Mechanics II
PHY 441	3	Advanced Mathematical Methods in Physics
PHY 450	1-4	Directed Research

Additional Major Requirements

*ENP 104	2	Introduction to Engineering and Software Tools
*ENP 105	1	Introduction to Engineering Ethics
COS 120	4	Introduction to Computer Science I
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations

Select one course from the following:

NAS 480	1	Natural Science Seminar
IAS 231H	2	Issues in Science and Religion *(Honors)*

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select one option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

**ENP 104 and 105 will substitute for the general education COS 104 requirement; alternatively, COS 104 may be taken.*

Additional courses in computer science, systems, engineering, and mathematics are strongly recommended.

Physics (BS)

The bachelor of science degree with a major in physics requires 89-97 hours in the major.

Major Requirements

ENP 370	1	Preparation for the Physics GRE
PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
PHY 321	3	Electricity and Magnetism
PHY 322	3	Waves and Physical Optics
PHY 330	2	Advanced Lab
PHY 341	3	Math Methods in Physics and Engineering
PHY 342	3	Analytical Mechanics
PHY 350	4	Thermodynamics and Statistical Mechanics
PHY 412	3	Quantum Mechanics
PHY 413	2	Quantum Mechanics II
PHY 441	3	Advanced Mathematical Methods in Physics
PHY 493	3	Physics Senior Capstone

Select one course from the following:

PHY 393	2	Practicum
PHY 450	2-4	Directed Research

Technical Electives

Select at least 11 additional hours from the following:

CHE 431	3	Physical Chemistry I
CHE 431L	1-2	Physical Chemistry I Lab
CHE 432	3	Physical Chemistry II
CHE 432L	1-2	Physical Chemistry II Lab
*ENP 200-499	1-11	Engineering Physics Electives
MAT 310	3	Mathematical Modeling with Numerical Analysis
MAT 352	4	Mathematical Statistics
MAT 382	3	Advanced Statistical Methods
PHY 201	4	Introductory Astronomy
*PHY 300-499	1-11	Physics Electives

**ENP 200-, 300-, 400-level & PHY 300- and 400-level courses not already used in major may be taken to meet the additional 11 hour requirement.*

Physics requirements continued on next page

Physics requirements continued from previous page

Additional Major Requirements

*ENP 104	2	Introduction to Engineering and Software Tools
*ENP 105	1	Introduction to Engineering Ethics
COS 120	4	Introduction to Computer Science I
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations

Select one course from the following:

NAS 480	1	Natural Science Seminar
IAS 231H	2	Issues in Science and Religion *(Honors)*

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select one option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

**ENP 104 and 105 will substitute for the general education COS 104 requirement; alternatively, COS 104 may be taken.*

Physics/Systems (BS)

This integrated major provides a strong background in physics, systems, management, mathematics and problem solving. The bachelor of science degree with a major in physics/systems requires 57-62 hours in the major and curriculum requirements in systems analysis. *All systems curriculum courses must be completed with a grade of C- or better.*

Major Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
PHY 321	3	Electricity and Magnetism
PHY 330	2	Advanced Lab
PHY 341	3	Math Methods in Physics and Engineering
PHY 342	3	Analytical Mechanics
PHY 393	3	Practicum
PHY 412	3	Quantum Mechanics
PHY 493	3	Physics Senior Capstone
ENP 332	4	Control Systems

Select one course from the following:

†ENP 351	3	Thermodynamics
†PHY 350	4	Thermodynamics and Statistical Mechanics

Electives

Select four additional hours of electives from:

ENP 252	4	Principles of Engineering
ENP 301	3	Statics and Dynamics
ENP 321	2	Applied Electromagnetics
ENP 331	4	Introduction to Electronics
ENP 341	4	Microcomputer Interfacing
†ENP 351	3	Thermodynamics
ENP 352	3	Materials Science and Solid State Physics
ENP 355	3	Fluid Mechanics and Water Flow
ENP 370	1-4	Selected Topics
ENP 431	4	Advanced Electronics and Microcircuits
PHY 201	4	Introductory Astronomy
PHY 313	2	Nuclear Radiation Experimental Methods
PHY 322	3	Waves and Physical Optics
†PHY 350	4	Thermodynamics and Statistical Mechanics
PHY 370	1-4	Selected Topics
PHY 413	2	Quantum Mechanics II
PHY 441	3	Advanced Mathematical Methods in Physics

†Courses in both areas may count only once.

Additional Major Requirements

*ENP 104	2	Introduction to Engineering and Software Tools
*ENP 105	1	Introduction to Engineering Ethics
MAT 251	4	Differential Equations

Select one course from the following:

NAS 480	1	Natural Science Seminar
IAS 231H	2	Issues in Science and Religion *(Honors)*

Select one of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

**ENP 104 and 105 will substitute for the general education COS 104 requirement; alternatively, COS 104 may be taken.*

Systems Requirements

COS 120	4	Introduction to Computer Science I
IAS 330	3	Human Relations in Organizations
MAT 151	4	Calculus I
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 382	3	Advanced Statistical Methods
SYS 101	3	Introduction to Systems
SYS 390	3	Information Systems Analysis
SYS 392	1	Systems Seminar
PHY 393	3	Practicum

Select one course from the following:

COS 121	4	Introduction to Computer Science II
COS 240	3	Business Application Programming

Select one course from the following:

MAT 210	4	Introductory Statistics
MAT 352	4	Mathematical Statistics

Select one course from the following:

SYS 401	4	Operations Research
SYS 402	4	Modeling and Simulation

Physics Minor

A minor in physics consists of 20 hours.

Minor Requirements

PHY 211	4	University Physics I
PHY 212	5	University Physics II

Electives

Select at least 11 elective hours of upper-division (300- or 400-level) physics and engineering courses.
ENP 252 may also meet elective hours.

Engineering Physics (BS)

The bachelor of science degree with a major in engineering physics requires the completion of 104-108 hours and is a general engineering degree which prepares students for industry practice or graduate study in a variety of engineering disciplines. This program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

Program Objectives:

1. Develop Christian leaders who serve God and humanity through active service to their family, church, job, and global community.
2. Develop competent engineers who use their broad knowledge of engineering, science, and mathematics to work in industry or complete advanced degrees.
3. Develop engineers who apply their ability to acquire new knowledge and skills, and who are imbued with the required knowledge, attitude, and experience to continuously strengthen their capabilities.
4. Develop engineers who utilize their project experience to efficiently and satisfactorily solve engineering problems using good problem management and design abilities.
5. Develop engineers who have a strong work ethic, collaborate effectively, demonstrate effective communication skills, and act in an ethically responsible manner.
6. Develop engineers who have an attitude and practice of innovation by effectively developing new solutions with an open mind to creative problem resolution.

Science and Math Requirements

MAT 151	4	Calculus I
MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
PHY 321	3	Electricity and Magnetism
PHY 341	3	Math Methods in Physics and Engineering

Select <u>one</u> course from the following:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I

Select <u>one</u> course from the following:

NAS 480	1	Natural Science Seminar
IAS 231H	2	Issues in Science and Religion *(Honors)*

Engineering Requirements

ENP 104	2	Introduction to Engineering & Software Tools
ENP 105	1	Introduction to Engineering Ethics
COS 120	4	Introduction to Computer Science I
ENP 252	4	Principles of Engineering
ENP 301	3	Statics and Dynamics
ENP 331	4	Introduction to Electronics
ENP 332	4	Control Systems
ENP 351	3	Thermodynamics
ENP 352	3	Materials Science and Solid State Physics
ENP 392	2	Junior Engineering Project
ENP 393	2	Practicum
ENP 491	1	Review of the Fundamentals of Engineering
ENP 492	2	Engineering Senior Capstone I
ENP 493	3	Engineering Senior Capstone II
ENP 494	1	Engineering Senior Capstone III

Other Requirements

ECO 201	4	Principles of Microeconomics
IAS 330	3	Human Relations in Organizations

<u>Tier A Electives</u>

(Tier A must total at least 15 hours.)

ENP 302	3	Strength of Materials and Machine Design
ENP 321	2	Applied Electromagnetics
ENP 333	3	Introduction to Solid State Devices
ENP 341	4	Microcomputer Interfacing
ENP 345	3	Fundamentals of Space Systems
ENP 355	3	Fluid Mechanics and Water Flow
ENP 357	3	Heat Transfer
ENP 394	2-4	Advanced Engineering Project
ENP 431	4	Advanced Electronics and Microcircuits
ENx xxx	4	Earth Science Elective
COS 121	4	Introduction to Computer Science II
COS 230	2	Missions Technology
COS 331	3	Data Communication
PHY 313	2	Nuclear Radiation Experimental Methods
SYS 390	3	Information Systems Analysis
SYS 403	3	Operations Management

<u>Tier B Electives</u>

(Tier A plus B must total at least 18 hours.)

PHY 322	3	Waves and Physical Optics
PHY 342	3	Analytical Mechanics
PHY 412	3	Quantum Mechanics
PHY 441	3	Advanced Mathematical Methods in Physics
ENT 422	3	New Venture Planning
MAT 245	4	Linear Algebra
MAT 352	4	Mathematical Statistics

Environmental Engineering (BS)

The bachelor of science degree with a major in environmental engineering requires 93-98 hours and provides a strong background in engineering and environmental science for students who plan to enter environment-related jobs or to attend graduate school.

Physics Requirements

ENP 104	2	Introduction to Engineering & Software Tools
ENP 105	1	Introduction to Engineering Ethics
ENP 252	4	Principles of Engineering
ENP 351	3	Thermodynamics
ENP 352	3	Materials Science and Solid State Physics
ENP 355	3	Fluid Mechanics and Water Flow
PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 313	2	Nuclear Radiation Experimental Methods
PHY 330	2	Advanced Lab
ENP 331	4	Introduction to Electronics
PHY 493	3	Physics Senior Capstone

Select <u>one</u> of the following chemistry course combinations:

CHE 201	4	General Chemistry I
CHE 202	4	General Chemistry II
or		
CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II

Select at least <u>three</u> hours of electives from:

CHE 311	4	Organic Chemistry I
COS 120	4	Introduction to Computer Science I
ENP 321	2	Applied Electromagnetics
ENP 332	4	Control Systems
ENP 341	4	Microcomputer Interfacing
ENP 431	4	Advanced Electronics and Microcircuits
PHY 311	4	Modern Physics
PHY 321	3	Electricity and Magnetism
PHY 341	3	Math Methods in Physics and Engineering
PHY 350	4	Thermodynamics and Statistical Mechanics
PHY 441	3	Advanced Mathematical Methods in Physics

Environmental Science Requirements

CHE 320	3	Environmental Chemistry
CHE 320L	1	Environmental Chemistry Lab
ENS 231	4	Introduction to Environmental Science
ENS 241	4	Physical Geology
ENS 355	4	Geospatial Analysis
ENS 402	4	Environmental Law and Policy

Select <u>four</u> hours of electives from:

ENS 341	4	Earth Materials
ENS 361	4	Geomorphology
ENS 362	4	Hydrogeology
ENS 363	4	Applied Geology and Environmental Planning

Select <u>one</u> course from the following:

ENS 393	2	Practicum
PHY 393	2	Practicum
ENP 393	2	Practicum

Students double majoring in engineering physics and environmental engineering do not have to complete <u>two</u> practicum courses.

Mathematics Requirements

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 251	4	Differential Equations
MAT 352	4	Mathematical Statistics

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Physics Science Education (BS)

The bachelor of science degree with a major in physics requires 89-91 hours of professional education courses and major courses. *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 310	2	Discipline and Classroom Management
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
NAS 309	2	Science Education Methods
SED 320	3	Exceptional Children

Major Requirements

COS 120	4	Introduction to Computer Science I
ENP 331	4	Introduction to Electronics
IAS 231H	2	Issues in Science and Religion *(Honors)*

Select <u>one</u> course from the following:

CHE 201	4	General Chemistry I
CHE 211	4	College Chemistry I

Additional Major Requirements

MAT 230	4	Calculus II
MAT 240	4	Calculus III
PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
PHY 330	2	Advanced Lab
PHY 493	3	Physics Senior Capstone

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Electives

Select <u>12</u> hours of electives from the following:

ENP 252	4	Principles of Engineering

ENP 300-/400-level courses
PHY 300-/400-level courses

Physical Science Education/Physics Concentration (BS)

The bachelor of science degree with a major in physical science and an emphasis in physics requires 75-80 hours of professional education courses, a physical science core and physics/ mathematics courses. *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 310	2	Discipline and Classroom Management
*EDU 332	3	The Junior High/Middle School
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
NAS 309	2	Science Education Methods
SED 320	3	Exceptional Children

**EDU 332 is required only for those seeking licensure in junior high/middle school.*

Physics Concentration

IAS 231H	1	Issues in Science and Religion *(Honors)*
MAT 240	4	Calculus III
PHY 311	4	Modern Physics
ENP 331	4	Introduction to Electronics

Physical Science Core

CHE 211	4	College Chemistry I
CHE 212	4	College Chemistry II
MAT 230	4	Calculus II
PHY 211	4	University Physics I
PHY 212	5	University Physics II

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

Electives

Select <u>four</u> hours of electives from the following:

ENP 252	4	Principles of Engineering

ENP 300-/400-level courses
PHY 300-/400-level courses

Physics/Mathematics Education (BS)

The bachelor of science degree with a major in physics/mathematics education requires 91-99 hours of professional education courses, physics and mathematics courses. *Secondary Education majors must complete specific general education requirements as outlined by the Education Department.*

Professional Education

EDU 150	3	Education in America
EDU 210	3	Writing for Teachers
EDU 260	3	Educational Psychology
EDU 309	1	Teaching in Secondary, Junior High/Middle Schools—Special Methods
EDU 310	2	Discipline and Classroom Management
*EDU 332	3	The Junior High/Middle School
EDU 415	1	Student Teaching Seminar
EDU 431	15	Supervised Internship in Secondary Schools
SED 320	3	Exceptional Children

Select <u>one</u> course from the following:

N7AS 309	2	Science Education Methods
MAT 309	2	Mathematics Education Methods

**EDU 332 is required only for those seeking licensure in junior high/middle school.*

Physics Core

COS 120	4	Introduction to Computer Science I
IAS 231H	2	Issues in Science and Religion *(Honors)*
PHY 211	4	University Physics I
PHY 212	5	University Physics II
PHY 311	4	Modern Physics
ENP 331	4	Introduction to Electronics

Select <u>one</u> course from the following:

PHY 493	3	Physics Senior Capstone
MAT 493	3	Mathematics Senior Capstone

Mathematics Core

MAT 230	4	Calculus II
MAT 240	4	Calculus III
MAT 245	4	Linear Algebra
MAT 251	4	Differential Equations
*MAT 280	3	Mathematics in the Junior High/Middle School
MAT 312	4	College Geometry
MAT 352	4	Mathematical Statistics

Select <u>one</u> option from the following:

MAT 151	4	Calculus I
†MAT 145	3	Introduction to Functions and Calculus
and		
†MAT 146	3	Functions and Calculus

†MAT 145 & 146 count as one option.

**MAT 280 is required only for those seeking licensure in junior high/middle school.*

Electives

Select <u>four</u> hours of electives from the following:

ENP 252	4	Principles of Engineering

ENP 300-/400-level courses
PHY 300-/400-level courses

Computer Engineering

Computer engineering is an interdisciplinary major offered jointly by the physics and engineering & computer science and engineering departments. *See computer science and engineering department (pages 165-174) for program details.*

Physics Courses

PHY 120 **4 hours**
Experiences in Physical Science
Intended for non-science majors. Selected topics from physical science are studied to afford insight into man's current understanding of natural phenomena, the models used to represent nature, and methods used in the quest to fathom the physical universe. Three hours of lecture and two hours of lab each week. *Meets general education physical science requirement. Offered intermittently.*

PHY 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

PHY 201 **3-4 hours**
Introductory Astronomy
A descriptive course about the solar system, stars and stellar evolution, and galaxies and the universe. Recent findings of space exploration and radio astronomy are included. Telescopes are provided for viewing sessions. Two or three hours of lecture and two hours of lab. *Physics or Engineering Physics majors wishing to take PHY 201 for elective credit must take the "majors-only" lab section that is offered periodically. Students interested in this option should consult with the department chair to determine availability of this special lab section. Students taking PHY 201 for elective credit should also check to ensure that they maintain the required minimum number of upper-division credit hours. Meets general education earth science requirement. Offered January interterm for three credit hours and fall semesters for four credit hours.*

PHY 203 **4 hours**
General Physics I
A study of mechanics, thermodynamics, waves and sound, electricity, magnetism, and optics. Assumes mathematics at the algebra-trigonometry level. For majors that do not require a calculus-based treatment of physics. *Meets general education physical science requirement. Three hours of lecture and two hours of lab. Offered annually.*

PHY 204 **4 hours**
General Physics II
See PHY 203.

PHY 211 **4 hours**
University Physics I
A calculus-based study of mechanics, waves and sound, electricity and magnetism, optics, fluids, and the structure of matter. *Meets general education physical science requirement. Three hours of lecture and two hours of lab. Corequisite: MAT 146 or 151. Offered annually.*

PHY 212 **5 hours**
University Physics II
Four hours of lecture and two hours of lab. See PHY 211. Prerequisite: PHY 211.

PHY 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

PHY 311 **4 hours**
Modern Physics
An introduction to modern physics, including special relativity, quantum effects of radiation and particles, atomic structure, and elementary particles. Three hours of lecture and two hours of lab per week. *Prerequisites: PHY 211, 212. Offered fall semester.*

PHY 313 **2 hours**
Nuclear Radiation Experimental Methods
A study of nuclear radiation and detection and experimental methods of measuring nuclear radiation. One hour of lecture and two hours of lab per week. *Prerequisites: PHY 211, 212. Offered spring semester of odd years.*

PHY 321 **3 hours**
Electricity and Magnetism
The vector field approach to electromagnetic theory. Includes electrostatics, magnetostatics, induction, dielectric and magnetic materials, and Maxwell's equations. *Co-requisites: MAT 251 and PHY 341. Prerequisites: PHY 211, 212. Offered fall semester of odd years.*

PHY 322 **3 hours**
Waves and Physical Optics
Applications of Maxwell's equations, including electromagnetic waves, wave guides, diffraction, and Fourier optics. *Prerequisites: PHY 211, 212, and 321. Offered spring semester of even years.*

PHY 330 **1-2 hours**
Advanced Lab
Students complete an open-ended project, laboratory experiment or research project. The individual project depends on student and faculty interests. Specific learning outcomes vary depending on faculty, student and project selected. *Prerequisites: ENP 252 or 301 or PHY 311 and junior classification. Offered as needed for physics and engineering physics majors.*

PHY 341 **3 hours**
Math Methods in Physics and Engineering
An application of analytical and computational methods to various mathematical topics, including linear algebra, matrices, eigenequations, vector field theory, partial differential equations, Fourier series and transforms, orthogonal functions, and complex analysis. Use of a computer application such as MATLAB is required. *Prerequisite: PHY 212. Corequisite: MAT 251. Offered spring semesters.*

PHY 342 **3 hours**
Analytical Mechanics
A formal treatment of mechanics covering harmonic motion, the translation and rotation of rigid bodies, noninertial reference frames, and gravitation. The course concludes with the Hamiltonian and Lagrangian formulations of mechanics. *Prerequisites: PHY 211, 212, 341. Offered spring semester of even years.*

PHY 350 **4 hours**
Thermodynamics and Statistical Mechanics
Develops thermal physics and statistical mechanics, with application to solid state physics. In the thermal physics portion of the course, the three laws of thermodynamics are developed and applied to problems. In the statistical mechanics portion, the development of the partition function is accomplished through the microcanonical formalism. The partition function is then applied to various problems, such as: Bose-Einstein and Fermi-Dirac statistics, Bose-Einstein condensation, blackbody radiation, and the behavior of electrons and phonons in solid materials. *Prerequisite: PHY 341. Offered fall of even years.*

PHY 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

PHY 370 **1-4 hours**
Selected Topics
Current topics include: Astrophysics, Space Science, and Preparation for the Physics GRE.

PHY 393 **1-4 hours**
Practicum
Supervised learning involving a first-hand field experience or a project. Generally, one hour of credit is awarded for a minimum of 40 hours of practicum experience. *Offered primarily during summer.*

PHY 412 **3 hours**
Quantum Mechanics
A quantum mechanical treatment of the free particle, harmonic oscillator and hydrogen atom. Includes creation and annihilation operators and an introduction to angular momentum. *Prerequisites: PHY 211, 212, 311 and 341. Offered spring semester of odd years.*

PHY 413 **2 hours**
Quantum Mechanics II
An in-depth treatment of several advanced topics in quantum mechanics. Topics covered include spin, angular momentum, three-dimensional problems, matrix mechanics, the density matrix, and perturbation theory. *Prerequisite: PHY 412. Offered fall semester of odd years.*

PHY 441 **3 hours**
Advanced Mathematical Methods in Physics
Application of analytical and computational methods to various advanced mathematical topics in physics, such as: group theory, complex analysis, partial differential equations, Green's functions, the Gamma function, Bessel functions, Legendre functions, and Fourier analysis. *Prerequisite: PHY 341. Offered fall of even years.*

PHY 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

PHY 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

PHY 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

PHY 493 **3 hours**
Physics Senior Capstone
A capstone course in which each senior's technical, analytical, and laboratory skills, along with coursework knowledge, are applied to an intensive physics or engineering project. Three weeks are devoted to the completion of the project, and the remainder of the term is spent off-campus, strengthening interpersonal relationships, integrating faith and learning, and examining topics critical to post-baccalaureate life. *Prerequisite: Senior status.*

Engineering Physics Courses

ENP 104 **2 hours**
Introduction to Engineering and Software Tools
This course introduces the students to the engineering discipline, providing a hands-on over-view of the tools they will acquire and use over the course of their major. These tools include process and methodology tools, analytical tools, software tools, and hardware tools. A goal of the course is to provide the students with a frame-work for their engineering studies along with a practical 'hands-on' example of what engineering might "look like." This framework should help the student better understand the role, need, and benefit of each successive course in their major. A group hardware project will be carried out as part of the course, helping to engage the students' learning and interest, and re-enforcing the concepts taught in class. *Offered January term every year.*

ENP 105 **1 hour**
Introduction to Engineering Ethics
Course introduces students to the ethical requirements of the engineering profession and the ethical issues associated with living in a technological intense digital society. Through the course, students should: appreciate the ethical use of computers and dangers of computer misuses, have knowledge of professional codes of ethics, be aware of the impact of technology on society, have an appreciation for the needs of society and how engineering can meet those needs, begin developing an understanding of how their Christian faith integrates with their engineering practice

ENP 170 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENP 252 **4 hours**
Principles of Engineering
This course introduces students to the engineering profession and prepares students for summer internships and upper-division course work and design projects. Topics include: design methodology, parametric 3D modeling, oral and written communication and engineering ethics. The course also introduces Statics, Materials, Thermodynamics, Fluid Statics, Heat Transfer and Finite Element Methods. This course includes a semester-long design project that integrates design methodology, CAD, communication and expertise in various engineering disciplines. *Prerequisites: ENP 104, MAT 230 and PHY 211 or permission of instructor. Offered spring semester.*

ENP 270 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENP 301 **3 hours**
Statics and Dynamics
This course is a one-semester introduction to the statics and dynamics of particles and rigid bodies. Topics include: forces, moments, equilibrium, structures in equilibrium, energy, momentum, kinematics and dynamics in planar and 3D problems. Course makes applications to engineering and uses software tools for engineering mechanics. *Prerequisite: ENP 252. Offered fall semester of even years.*

ENP 302 **3 hours**
Strength of Materials and Machine Design
Course investigates the fundamentals of strength of materials and machine design. The strength of materials section covers stress – strain relationships, axial loading, torsion, beam loading and linear buckling. The machine design portion applies the fundamental knowledge of statics, dynamics and strength of materials to mechanical components and integration of components into systems. Prerequisite: ENP 301.

ENP 321 **2 hours**
Applied Electromagnetics
The course considers the application and technology of electromagnetic field theory to computing and communications systems. Topics may include wave propagation, transmission lines, fiber optics, high frequency communication networks, antennas, and satellite communications. *Prerequisites: ENP 252, MAT 251, and ENP 331. Offered fall semester of even years.*

ENP 341 **4 hours**
Microcomputer Interfacing
Course develops the student's ability to design, build and test embedded systems. Hardware architecture and software programming of microcontrollers and other embedded system devices are studied. Operation and use of LCDs, AtoD and DtoA converters, keypads and other interface devices are investigated. Serial communication through I2C, OneWire, USB and RS232 are used. In addition, networking and RF techniques and protocols are studied. *Prerequisite: ENP 331 or permission of instructor. Offered spring semester of odd years.*

ENP 331 **4 hours**
Introduction to Electronics
Introductory concepts and experiments designed to acquaint students with the operation and application of modern electronic devices and components. Experiments dealing with elementary concepts of electricity, electrical measurements, diodes, transistors, integrated circuits, and a variety of solid state devices, as well as digital electronics, are provided. Three hours of lecture and one three-hour lab each week. *Prerequisites: PHY 211, 212. Offered fall semester.*

ENP 332 **4 hours**
Control Systems
Linear and nonlinear systems with analytical methods, modeling, forcing functions, response analysis, feedback, stability, control systems, mechanical and fluid systems, electrical systems, three phase circuits and machines, transmission lines, and communications. MATLAB and Interactive Physics software tools are used. *Prerequisites: ENP 252, MAT 251, or permission of instructor. Offered fall semester of even years.*

ENP 333 **3 hours**
Introduction to Solid State Devices
The course emphasizes the physical foundations underlying properties and operation of modern electronic and photonic devices. The content includes: crystalline structures and quantum mechanics, energy bands in semiconductor (in comparison with metals and insulators), electrons and holes in semiconductors, doping (p and n type), state occupation statistics, transport properties of electrons and holes, p-n junctions, bipolar transistors, MOSFETs and JFTs, In addition, metal devices (e.g. quantum interferometers) and optical devices (dielectrics and waveguides, and photonic crystals) will also be discussed. *Prerequisite: ENP 331.*

ENP 345 **3 hours**
Fundamentals of Space Systems
Course is an introduction to space systems, the atmosphere, and astronomy. Course includes study and lab experiments coupled to the atmospheric and space environments, atmospheric and space sensors, orbits, nanosatellites, remote sensing, and penetrating nuclear radiation. *Prerequisites: PHY 212.*

ENP 351 **3 hours**
Thermodynamics
Course develops engineering thermodynamics including use of the first and second law, phase diagrams, properties, heat transfer, second law consequences, power and refrigeration cycles as well as other selected topics. *Prerequisites: MAT 251, PHY 212, ENP 252. Offered fall semester of odd years.*

ENP 352 **3 hours**
Materials Science and Solid State Physics
The structure, processing, and properties of engineering materials are studied, with an emphasis on metallic systems. This includes: crystal structure, defects, diffusion, phase transformations, deformation mechanisms, strength, and fracture toughness. Also covered are material selection, linear elastic fracture mechanics, and dislocation theory. Course contains a significant research component. *Prerequisite: ENP 252. Offered spring semester of even years.*

ENP 355 **3 hours**
Fluid Mechanics and Water Flow
An introduction to the basic properties of fluids in motion. Topics include: Differential fluid equations, streamlines, continuity, energy and linear angular momentum, incompressible viscous flow, potential flow, Navier-Stokes equations, open channel flow, pipe flow, laminar and turbulent boundary layers. *Prerequisite: ENP 252. Corequisite: MAT 251. Offered fall semester of odd years.*

ENP 357 **3 hours**
Heat Transfer
Course investigates the fundamentals of heat transfer and applies those fundamentals to engineering applications. Topics covered include modeling of conduction, convection, radiation and mixed mode heat transfer problems. Course covers both steady state and transient response and make applications to satellite thermal control and cooling of electrical devices. *Prerequisite: ENP 252*

ENP 360 **1-4 hours**
Independent Study
An individualized, directed study involving a specified topic.

ENP 370 **1-4 hours**
Selected Topics
A course offered on a subject of interest but not listed as a regular course offering. *May count toward the departmental major and general education requirements.*

ENP 392 **2-4 hours**
Junior Engineering Project
In the context of completing an engineering project, students learn and practice: elements of the design process, the ability to be innovative and think creatively, the ability to acquire new knowledge and skills, the ability to solve engineering problems, the application of analytical or software tools to engineering problems, and the ability to communicate effectively. *Prerequisite: ENP 252.*

ENP 393 **1-4 hours**
Practicum
Engineering Practicum is a supervised work experience which integrates significant activities in an industrial setting with principles and skills learned through the educational program. Practicum must involve a significant engineering work experience, and preference is given to an experience away from the Taylor campus. Practicum may be completed between either the sophomore and junior years or between the junior and senior years. *Offered primarily during summer. Prerequisite: ENP 252.*

ENP 394 **2-4 hours**
Advanced Engineering Project
Students complete an open-ended project, laboratory experiment or research project. The individual project depends on student and faculty interest. Many projects are externally funded. Specific learning outcomes vary depending on faculty, student, and project selected. *Prerequisite: ENP 252.*

ENP 431 **4 hours**
Advanced Electronics and Microcircuits
Theoretical analog and digital VLSI microcircuit design principles are studied. Implementation and advanced design of digital programmable logic arrays and layout of analog microchips is performed in the lab portion of this course. Electronics topics also include Karnaugh maps and minimization, sequential logic and state machines, device modeling with computer-aided design, controllers, computer hardware, architecture, memories, and interrupt systems. *Prerequisites: ENP 252, ENP 331. Offered spring semester of even years.*

ENP 450 **1-4 hours**
Directed Research
Investigative learning involving closely directed research and the use of such facilities as the library or laboratory.

ENP 480 **1-4 hours**
Seminar
A limited-enrollment course designed especially for upper-class majors with emphasis on directed readings and discussion.

ENP 490 **1-2 hours**
Honors
Individualized study or research of an advanced topic within a student's major. Open to students with at least a 3.00 GPA in the major field.

ENP 491 **1 hour**
Review of the Fundamentals of Engineering
Course reviews the fundamentals of engineering and prepares students to enter the engineering profession. Depending on students incoming ability, the course will review subjects from chemistry, computers, dynamics, electric circuits, engineering economics, ethics, fluid mechanics, materials science, mathematics, mechanics of materials, statics and thermodynamics. *Prerequisite: Senior status. Offered fall of every year.*

ENP 492 **2 hours**
Engineering Senior Capstone I
Course is the first of a three-course culminating experience which prepares students for engineering practice through a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social and political. *Prerequisites: Senior status. Offered fall semester.*

ENP 493 **3 hours**

Engineering Senior Capstone II

Course is the second of a three-course culminating experience which prepares students for engineering practice through a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social and political. Course also prepares students to serve God and humanity through active service to their family, church, employer and global community. *Prerequisite: ENP 492. Offered January interterm.*

ENP 494 **1 hour**

Engineering Senior Capstone III

Course is the third of a three-course culminating experience which prepares students for engineering practice through a major design experience based on the knowledge and skills acquired in earlier course work and incorporating engineering standards and realistic constraints that include most of the following considerations: economic, environmental, sustainability, manufacturability, ethical, health and safety, social and political. Course focuses mainly on documenting and presenting work completed in the first two courses of the capstone experience. *Prerequisite: ENP 493. Offered spring semester.*