College of Science and Engineering

Michael J. Quinn, PhD, Dean
Jean Jacoby, PhD, Associate Dean
Mara Rempe, PhD, Associate Dean

Objectives

Rooted in the Jesuit tradition of liberal education, the College of Science and Engineering at Seattle University seeks to provide dynamic, integrated, and challenging academic programs in science, engineering, and health. The college is dedicated to preparing students for responsible roles in their chosen professions and to advancing the educational qualifications of practicing professionals. The college seeks to foster among all students an understanding of scientific inquiry and a critical appreciation of technological change, and to inspire them to lifelong intellectual, professional, and human growth.

Degrees Offered
Bachelor of Arts with a major in biology, chemistry, computer science, mathematics, or physics
Bachelor of Science with a major in mathematics
Bachelor of Science in Biochemistry
Bachelor of Science in Biology
Bachelor of Science in Chemistry
Bachelor of Science in Civil Engineering
Bachelor of Science in Civil Engineering with a specialization in environmental engineering
Bachelor of Science in Computer Science
Bachelor of Science in Computer Science with a specialization in business
Bachelor of Science in Computer Science with a specialization in mathematics
Bachelor of Science in Diagnostic Ultrasound
Bachelor of Science in Electrical Engineering
Bachelor of Science in Electrical Engineering with a specialization in computer engineering
Bachelor of Science in Environmental Science
Bachelor of Science in General Science
Bachelor of Science in General Science with a pre-professional specialization
Bachelor of Science in Mathematics
Bachelor of Science in Mathematics with a specialization in applied math
Bachelor of Science in Mathematics with a specialization in pure math
Bachelor of Science in Mechanical Engineering
Bachelor of Science in Physics
Master of Software Engineering –See *Graduate Bulletin*

Students interested in other scientific, technical, and health-related careers, such as medicine or dentistry, may pursue a degree within a specific discipline and use elective courses to suit their needs, or they may tailor their complete curriculum within the general science degree.

Certificate of Post-Baccalaureate Studies
Pre-professional Health Studies Certificate

Pre-Science and Pre-Engineering

Many students come to Seattle University interested in science or engineering but unsure of the focus of their studies.

Pre-Science offers the opportunity to explore the different science programs while being a part of the College of Science and Engineering. Certain courses are common to all science programs, so there is time to learn about the degree programs available. Advisors help direct students toward a major that fits their interests and talents.

Jennifer Sorensen, PhD, Pre-Science Advisor
Phone (206) 296-5591
E-mail pre-sci@seattleu.edu

Pre-Engineering provides an opportunity to get started in an engineering program while learning about the different branches of engineering. Initially the curriculum consists of common classes for all engineering disciplines, giving students time to choose the best program for them. Advisors help direct students toward a major that fits their interests and talents.

Mary Kelly, Pre-Engineering Advisor
Phone (206) 296-2542
E-mail pre-eng@seattleu.edu

Accreditation

Individual programs within the college are accredited by the following professional bodies:

- Engineering Accreditation Commission of ABET (civil engineering, electrical engineering, and mechanical engineering)
- Commission on Accreditation of Allied Health Education Programs (diagnostic ultrasound)
- In addition the Chemistry Department is approved by the American Chemical Society to grant ACS certified B.S. degrees in chemistry and biochemistry. See departmental listing for requirements.

Admission Requirements

Freshmen applicants for admission to the College of Science and Engineering must have completed at least four years of high school mathematics, including the equivalent of pre-calculus, except for Pre-Science. At least two years of laboratory science for all majors except mathematics and computer science. Laboratory biology and chemistry are required for BS Biology, and laboratory chemistry and physics are required for all engineering programs.

Transfer applicants will be considered when their overall college grade point average is at least 2.50 on a 4.00 scale and when their cumulative grade point average in all engineering, mathematics, or science courses is also at least 2.50. A history of withdrawals, incompletes, and repeated courses lessens the chances for admission. To be accepted for transfer credit, required engineering, mathematics, or science courses must be graded C (2.00) or above. No technology courses will be accepted as transfer credit.

College of Science and Engineering Requirements

Students seeking the bachelor's degree in the College of Science and Engineering must complete a minimum of 180 credits, including the university core curriculum requirements. A bachelor of science in civil engineering or in civil engineering with a specialization in environmental engineering requires 192 credits. For all of the engineering programs, for all degrees in computer science, diagnostic ultrasound, and for the bachelor of science in mathematics, the student's cumulative grade point average for graduation must be at least 2.50. In addition, for these programs, the minimum Seattle University grade point average for all courses applied to major and major department requirements is 2.50.

The core requirements have been modified for several of the degree programs, as described in the individual departmental sections of this *Bulletin*, but in no case may a student have fewer than 45 credits in the combination of history, humanities, and social sciences. Students also must complete the specific departmental requirements for their particular degree.

A maximum of 15 credits taken by an undergraduate non-matriculated student may be applied toward a baccalaureate degree in the College of Science and Engineering. For post-baccalaureate students taking courses in preparation for graduate health professional programs, any pre-professional courses taken in non-matriculated status may be applied toward a second bachelor's degree in the College of Science and Engineering.

No course may be taken without the indicated prerequisites. Only the dean may waive this policy.

Biology

Daniel Smith, PhD, Chair

Objectives

Biology is the study of life at all levels, from the molecular to the global. A vital part of liberal education, knowledge of biology provides insights into the nature of the human body, social structure and behavior, as well as the ecological interrelationships, genetics and evolution, physiological functions, cellular and molecular processes of all living things.

Emphasizing laboratory and field work, the bachelor of science in biology is designed to prepare students for careers in the life sciences, for graduate work in basic and applied research and for professional careers in medicine, dentistry, veterinary medicine, and teaching. Working within the general requirements of the biology major, it is possible to structure your course work to create programs with an emphasis in ecology, marine biology, cellular and molecular biology, zoology, or microbiology.

The bachelor of arts major in biology is designed for those students who would like to incorporate a biology degree into a broader liberal arts education or for those students who plan to integrate a background in biology into a related career path. The program will offer the students exposure to the breadth of the field of biology and still allow them the opportunity to combine their science training with expanded course work in other disciplines. Possible multi-disciplinary combinations could prepare students for careers in science writing or illustration, genetic counseling, environmental policy, or business in the biotechnology industry.

The bachelor of arts major in biology with a specialization in humanities for teaching is a program designed to prepare students for a career in science teaching. A full description of this program can be found in the introductory pages to the College of Science and Engineering.

Students specifically interested in premedical, pre-dental, or pre-veterinary medicine should also consult the pre-professional section of this *Bulletin*.

Degrees Offered

Bachelor of Arts
Bachelor of Science in Biology

Majors Offered

Biology
Biology with specialization in Humanities for Teaching

Minor Offered

Biology

Bachelor of Arts
Major in Biology

In order to earn the bachelor of arts degree with a major in biology, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**..5

Fine Arts (one approved 5 credit course; see course descriptions)...5

PHIL 220	**Philosophy of the Human Person**...5

Social Science I 5
Social Science II (different discipline from Social Science I)...5
Theology and Religious Studies I (200-299)..5
Ethics (upper division)..5
Theology and Religious Studies II (300-399)...5
Interdisciplinary   ....3 to 5
Senior Synthesis satisfied by BIOL 487 and 488

II. Major Requirements

43 total credits in biology, including:

BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
BIOL 162	**Biology II: Evolution and Ecology**	4
BIOL 172	**Biology II Lab**	1
BIOL 163	**Biology III: Physiology and Development**	4
BIOL 173	**Biology III Lab**	1
BIOL	**Electives (not 101)**	10

Choose one of the following five courses:...5

BIOL 220	**Microbiology**
BIOL 240	**Genetics**
BIOL 300	**Microbiology**
BIOL 440	**Molecular Genetics**
BIOL 485	**Cell Biology**

Choose one of the following six courses:...5

BIOL 200	**Anatomy and Physiology I**
BIOL 210	**Anatomy and Physiology II**
BIOL 310	**Developmental Biology**
BIOL 325	**Comparative Anatomy of the Vertebrates**
BIOL 385	**Plant Physiology**
BIOL 388	**Animal Physiology**

Choose one of the following five courses 5

BIOL 235	**Invertebrate Zoology**
BIOL 252	**Taxonomy of Flowering Plants**
BIOL 275	**Marine Biology**
BIOL 320	**Evolution**
BIOL 470	**General Ecology**

Senior Synthesis:

BIOL 487	**Independent Experience**	1 to 4
BIOL 488	**Seminar**	1

III. Other Major Department Requirements

15 credits in chemistry, typically:..15
CHEM 121/131 General Chemistry I with Lab
CHEM 122/132 General Chemistry II with Lab
CHEM 123/133 General Chemistry III with Lab
Other courses with approval of the Biology Department

Choose option a, b, or c:...5 to 10

a. MATH 131	**Calculus for Life Sciences**	
b. MATH 134	**Calculus I**	
c. MATH 120	**Precalculus: Algebra**	
PSYC 201	**Statistics for Non-Majors**	

Science elective (approved by department) 5

NOTE: At least 10 credits of the 40 non-senior synthesis biology course credits must be from 300- or 400-level courses. Some of the course choices may require prerequisites beyond the minimal degree requirements. A maximum of 5 credits of directed and or independent study in biology can be counted toward the 10 credits of biology electives.

Bachelor of Arts
Major in Biology
Specialization in Humanities for Teaching

In order to earn the bachelor of arts major in biology degree with a specialization in humanities for teaching, students must complete a minimum of 180 quarter credits with a cumulative grade point average of 2.50 and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150	**Composition: Language and Thought**	**5**
HUMT 151	**Composition: Language and the Arts**	**5**
HUMT 152	**Logic, Ethics, and Discernment**	**5**
HUMT 161	**Humanities: Introduction to Tutoring**	**2**
HUMT 162	**Humanities: Introduction to Tutoring**	**1**
HUMT 163	**Humanities: Introduction to Tutoring**	**1**
HUMT 171	**Proseminar: Humanistic Foundations of Education**	**5**
HUMT 180	**Socio-Cultural Transformations I**	**5**
HUMT 181	**Socio-Cultural Transformations II**	**5**
HUMT 182	**Socio-Cultural Transformations III**	**5**
HUMT 273	**Seminar on Secondary Education**	**5**
HUMT 274	**Supervised Internship in Secondary Education**	**5**
HUMT 301	**Perspectives on the Person I**	**5**
HUMT 302	**Perspectives on the Person II**	**5**
HUMT 371	**Education and the Polity**	**5**
HUMT 372	**Leadership and Teaching**	**5**
HUMT 380	**Cultural Interface**	**5**
HUMT 400	**Seminar on Contemporary Problems**	**5**
HUMT 471	**Jesuit Education**	**5**
HUMT 472	**Jesuit Education Practicum**	**5**
CISS 120	**Poverty in America**	**5**

II. Major Requirements

48 total credits in biology, including:

BIOL 161	**Biology I: Molecular and Cellular Biology** 4	
BIOL 171	**Biology I Lab** 1	
BIOL 162	**Biology II: Evolution and Ecology** 4	
BIOL 172	**Biology II Lab** 1	
BIOL 163	**Bio III: Physiology and Development** 4	
BIOL 173	**Biology III Lab** 1	
BIOL 240	**Genetics** 5	
BIOL 470	**General Ecology** 5	
BIOL	**Elective (approved by department)** 5	

Choose one of the following four courses: 5

BIOL 235	**Invertebrate Zoology**
BIOL 310	**Developmental Biology**
BIOL 325	**Comparative Vertebrate Anatomy**
BIOL 388	**Animal Physiology**

Choose one of the following three courses: 5

BIOL 220	**Microbiology**
BIOL 300	**Microbiology**
BIOL 485	**Cell Biology**

Choose one of the following two courses: 5

BIOL 252	**Taxonomy of Flowering Plants**
BIOL 385	**Plant Physiology**

Senior Synthesis:

BIOL 487	**Independent Experience** .... 1 to 4
BIOL 488	**Seminar** 1

III. Other Major Department Requirements

17 credits in chemistry, including:

15 credits in general chemistry, typically: **15**

CHEM 121/131 General Chemistry I with Lab

CHEM 122/132 General Chemistry II with Lab

CHEM 123/133 General Chemistry III with Lab

Other courses with approval of the Biology Department

CHEM 260	**Laboratory Safety** 2

Choose option a, b, or c: .... 5 to 10

a. MATH 131	**Calculus for Life Sciences**
b. MATH 134	**Calculus I**
c. MATH 120	**Precalculus: Algebra**
PSYC 201	**Statistics for Non-Majors**

Science elective (approved by department) **5**

NOTE: At least 10 credits of the 48 non-senior synthesis biology course credits must be from 300 or 400-level courses. Some of the course choices may require prerequisites beyond the minimal degree requirements. For a secondary endorsement in general science, 5 credits of earth science and 5 credits PHYS 105 are required and will satisfy the science elective.

Bachelor of Science in Biology

In order to earn the bachelor of science in biology degree, students must complete a minimum of 180 quarter credits with a cumulative and major/program grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	College Writing: Inquiry and Argument	5
PHIL 110	Introduction to Philosophy and Critical Thinking	5

Choose one of the following two courses: 5

HIST 120	Origins of Western Civilization
HIST 121	Studies in Modern Civilization

ENGL 120	Introduction to Literature	5

Fine Arts (one approved 5 credit course; see course descriptions) 5

PHIL 220	Philosophy of the Human Person	5
Social Science I		5

Social Science II (different discipline from Social Science I) 5
Theology and Religious Studies I (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies II (300-399) 5
Interdisciplinary .... 3 to 5
Senior Synthesis satisfied by BIOL 487 and 488

II. Major Requirements

57 credits in biology, including:

BIOL 161	Biology I: Molecular and Cellular Biology	4
BIOL 171	Biology I Lab	1
BIOL 162	Biology II: Evolution and Ecology	4
BIOL 172	Biology II Lab	1
BIOL 163	Biology III: Physiology and Development	4
BIOL 173	Biology III Lab	1
BIOL 240	Genetics	5
BIOL 470	General Ecology	5
BIOL 485	Cell Biology	5
BIOL	Electives (not BIOL 101, 200, 210, or 220)	10

Choose one of the following three courses: 5

BIOL 235	Invertebrate Zoology
BIOL 252	Taxonomy of Flowering Plants
BIOL 320	Evolution

Choose one of the following four courses: .... 4 or 5

BIOL 310	Developmental Biology	5
BIOL 325	Comparative Anatomy of the Vertebrates	5
BIOL 330	Comparative Vertebrate Histology	5
BIOL 361	Ultrastructure	4

Choose one of the following two courses: 5

BIOL 385	Plant Physiology
BIOL 388	Animal Physiology

Senior Synthesis:

BIOL 487   **Independent Experience** .... 1 to 4

BIOL 488   **Seminar** 1

NOTE: One course of plant science beyond the 161/171–163/173 series is required. A maximum of 5 credits of directed and or independent study in biology can be counted toward the 10 credits of biology electives.

III. Other Major Department Requirements

CHEM 121   **General Chemistry I** 4

CHEM 131   **General Chemistry Lab I** 1

CHEM 122   **General Chemistry II** 4

CHEM 132   **General Chemistry Lab II** 1

CHEM 123   **General Chemistry III** 4

CHEM 133   **General Chemistry Lab III** 1

Choose organic chemistry sequence a or b .... 16, 17 or 18

a. CHEM 335   **Organic Chemistry I (3)**

    CHEM 345   **Organic Chemistry Lab I (2)**

    CHEM 336   **Organic Chemistry II (3)**

    CHEM 346   **Organic Chemistry Lab II (2)**

    CHEM 337   **Organic Chemistry III (4)**

    CHEM 347   **Organic Chemistry Lab III (2)**

b. CHEM 231   **Fundamental Organic Chemistry I (4)**

    CHEM 241   **Fundamental Organic Chemistry Lab I (2)**

    CHEM 232   **Fundamental Organic Chemistry II (4)**

    CHEM 242   **Fundamental Organic Chemistry I Lab II (2)**

Choose one of three:

    CHEM 319   **Quantitative Analysis (5)**

    BIOL 305   **Molecular Biology Projects Laboratory (5)**

    CHEM 454 & 456   **Biochemistry I & III (3 & 3)**

Choose group a or b 10

a. MATH 131   **Calculus for Life Sciences**

    PSYC 201   **Statistics for Non-Majors**

b. MATH 134   **Calculus I**

    MATH 135   **Calculus II**

Choose physics series a or b 15

a. PHYS 105   **Mechanics**

    PHYS 106   **Waves, Sound, Electricity and Magnetism**

    PHYS 107   **Thermodynamics, Optics, and Modern Physics**

b. PHYS 121   **Mechanics**

    PHYS 122   **Electricity and Magnetism**

    PHYS 123   **Waves and Optics**

Minor in Biology

In order to earn a minor in biology, students must complete 30 credits in biology, including:

BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
BIOL 162	**Biology II: Evolution and Ecology**	4
BIOL 172	**Biology II Lab**	1
BIOL 163	**Biology III: Physiology and Development**	4
BIOL 173	**Biology III Lab**	1
BIOL	**Electives (15 credits numbered 200 or above)**	15

NOTE: At least 5 of the elective course credits must be from courses numbered 300 or above. Some of the course choices may require prerequisites beyond the minimal requirements for the minor.

See policy for minors (84-1) for more information.

Biology Courses

BIOL 101   Principles of Biology 5
Important areas of biology, beginning at the cellular level and culminating with a consideration of interactions and changes in natural populations. Four lecture and three laboratory hours per week. Credits not applicable to biology major. (fall, winter, spring)

BIOL 161   Biology I: Molecular and Cellular Biology 4
A survey of the biological world, concepts and principles—an introduction to cell biology, metabolism, respiration, photosynthesis, genetics and molecular biology. Four lectures per week. Prerequisite: high school chemistry and placement into MATH 120 or higher. Co-requisite: BIOL 171. (fall, winter)

BIOL 162   Biology II: Evolution and Ecology 4
A survey of the biological world, concepts and principles—an introduction to evolution, diversity, comparisons of groups of living organisms and ecology. Four lectures per week. Prerequisite: BIOL 161/171 (with C- or better) Co-requisite: BIOL 172. (winter)

BIOL 163   Biology III: Physiology and Development 4
A survey of the biological world, concepts and principles—an introduction to development differentiation, and comparative functions of tissues and organ systems. Four lectures per week. Prerequisite: BIOL 161/171 (with C- or better). Co-requisite: BIOL 173. (spring)

BIOL 171   Biology I Lab 1

BIOL 172   Biology II Lab 1

BIOL 173   Biology III Lab 1
In addition to illustrating the material from the lecture sessions, the laboratory sessions in the series are an introduction to basic laboratory procedures and practices for scientific inquiry. Students will work on developing observational skills, collecting and analyzing qualitative and quantitative data, experimental design, and presentation of experimental results. Three hours per week. Prerequisite: BIOL 171 for BIOL 172, and BIOL 171 for BIOL 173. Co-requisites: BIOL 161 for BIOL 171, BIOL 162 for BIOL 172, BIOL 163 for BIOL 173. (BIOL 171 fall, winter; BIOL 172 winter; BIOL 173 spring)

BIOL 200   Anatomy and Physiology I 5
Major structural and functional systems of the human body. Cells, tissue, bone, muscle, and nervous system. Laboratory emphasis on microscopic and gross anatomy. Credits not applicable to a BS in biology major. Four lecture and three laboratory hours per week. (fall)

BIOL 210   Anatomy and Physiology II **5**
Major structural and functional systems of the human body. Digestive, circulatory, respiratory, endocrine, urinary, and reproductive systems. Physiological interactions among systems. Laboratory emphasis on physiology. Credits not applicable to a BS in biology major. Four lecture and three laboratory hours per week. Prerequisite: BIOL 200. (winter)

BIOL 220   Microbiology.. **5**
Introduction to microbiology, emphasizing health-related aspects. Four lecture and three laboratory hours per week. Credits not applicable to a BS in biology major. Co-requisite: BIOL 210. (winter, spring)

BIOL 235   Invertebrate Zoology **5**
Survey of invertebrate phyla including their anatomy, morphology, taxonomy, and ecology. Four lecture and three hours laboratory per week. One weekend field trip. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better). (fall)

BIOL 240   Genetics **5**
Introduction to the principles of inheritance with an emphasis on the transmission of genetic information from one generation to the next. Topics include Mendelian and non-Mendelian inheritance, dominance, linkage, gene interactions, sex determination and sex linkage, polygenic inheritance, human medical genetics, and maternal effects. Five lectures per week. Prerequisites: BIOL 161/171. 162/172, 163/173 (all with C- or better), or instructor permission. (fall, winter)

BIOL 252   Taxonomy of Flowering Plants... **5**
Native flora as an introduction to taxonomy, involving the principal orders and families of flowering plants. Three lecture and four laboratory hours per week. One weekend field trip is required. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better). (spring)

BIOL 275   Marine Biology **5**
Study of the marine environment and the animals and plants inhabiting it. Four lecture and three laboratory hours per week and one weekend field trip. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better). BIOL 235 recommended. (spring)

BIOL 291-293   Special Topics.. **1 to 5**
BIOL 296   Directed Study .... **1 to 5**
BIOL 297   Directed Reading .... **1 to 5**
BIOL 300   Microbiology.. **5**
Basic biology of micro-organisms, including morphology, physiology, genetics, and ecology, with some aspects of applied and medical microbiology. Four lecture and three laboratory hours per week. Prerequisite: BIOL 161/171, 162/172, 163/173 (all with C- or better). CHEM 123/133. (fall)

BIOL 305   Molecular Biology Projects Lab **5**
Application of molecular techniques to biological questions. Theory and use of molecular biology methods and study of molecular approaches in current research. Emphasis on experimental design, data interpretation, and development of an independent project. Two lecture and six laboratory hours per week. Prerequisite: BIOL 161/171, 162/172, 163/173, CHEM 123/133, BIOL 240 (all with a C- or better). (winter)

BIOL 310   Developmental Biology **5**
Early embryo development with consideration of gametogenisis, fertilization, gastrulation, cell differentiation, and organogenesis. Four lecture and three laboratory hours per week. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better). (spring)

BIOL 320   **Evolution**.. **5**

Course content includes natural and sexual selection, evolutionary genetics, experiments in evolution, evolution and health, macroevolution, and special topics of our choice. The course format includes lectures, student-led presentations and discussions, and original laboratory research. Student presentations explore the scientific literature, debate their conclusions, and provide practice giving effective talks. The laboratories allow students to research, design, conduct, statistically analyze, and write scientific papers on experiments in evolution. Four lecture and three laboratory hours per week. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with a C- or better). (fall)

BIOL 325   **Comparative Anatomy of the Vertebrates**................................ **5**

Comparative study of the structures of the integumentary, muscular, skeletal, digestive, respiratory, excretory, reproductive, circulatory, and nervous systems of selected vertebrates with emphasis on evolutionary relationships between organisms. Four lecture and three laboratory hours per week. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better). (winter)

BIOL 330   **Comparative Vertebrate Histology**... **5**

Study of the fundamental body tissues. Three lecture and four laboratory hours per week. Recommended BIOL 310 or 325. (winter)

BIOL 340   **Epidemiology and Public Health**... **3**

Introduction to the discipline of epidemiology and it relationship to the field of public health. A survey of the various sub-disciplines of epidemiology and the research methods used in the field. Prerequisites: BIOL 240 and MATH 120, junior standing. (winter)

BIOL 361   **Ultrastructure** **4**

The examination of cellular structure as seen through the electron microscope. Introduction to theory of operation of the electron microscope, interpretation of electron micrographs, comparisons of fine structure of different cell types, correlations of structures with cellular functions, examples of research applications. Lecture/demonstration format; three lectures and one demonstration period per week. Prerequisite: BIOL 161/171, 162/172, 163/173 (all with C- or better) and instructor permission. (winter)

BIOL 380   **Animal Behavior** **5**

Course goals include gaining a broad understanding and an increased fascination for why animals behave as they do, and the skill to create and answer questions in this field of biology. The course examines how genetics, development, ecology and evolution shape behaviors including communication, choosing mates, avoiding predators, finding food, and social interactions. Four lecture and three laboratory hours per week. One weekend field trip. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with a C- or better). (spring)

BIOL 385   **Plant Physiology** **5**

Study of the function of plants, with emphasis on the wide range of physiological process that may contribute to success and survival of plants in their environment. Transport mechanisms; water and mineral management; responses to light, including photosynthesis, photoperiodism, and photomorphogenesis; functions of plant hormones; responses to environmental stresses; events in development. Four lecture and three laboratory hours per week. Individual project. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better); CHEM 337/347 or CHEM 232/242. (spring)

BIOL 388   **Animal Physiology** **5**

Study of the function of animals, with emphasis on processes that contribute to the success and survival of animals in their respective environments. Nerve and muscle function, hormonal regulation, osmoregulation, digestion, and thermoregulation. Four lecture and three laboratory hours per week. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better); CHEM 232/242 or CHEM 337/347. (fall)

BIOL 391-393   **Special Topics**... **1 to 5**

BIOL 396   **Directed Study** .... 1 to 5

BIOL 415   **Fundamentals of Immunology** 3

Humoral and cellular immune systems; clonal selection theory; antigen and antibody properties and interactions, immunological diversity; autoimmune diseases; AIDS; cancer immunology; monoclonal antibodies and immunotherapy. Prerequisites: BIOL 161/171 (with C- or better), 200/210; CHEM 337 or CHEM 232. (spring)

BIOL 422   **Medical Microbiology** 3

Study of clinically significant bacterial and viral pathogens. Characteristics of pathogenic microorganisms and their mechanisms of pathogenesis at the cellular and molecular level will be emphasized. Epidemiological and immunological aspects of microbial diseases will also be considered. Three lecture hours per week. Prerequisites: BIOL 220 or 300; CHEM 337, or CHEM 232. (spring)

BIOL 440   **Molecular Genetics** 5

Study of heredity at the molecular level, including gene structure, transcription, mutation, DNA replication, recombinant DNA methodologies and their applications. Four extended lectures per week. Prerequisites: BIOL 161/171 (with C- or better); BIOL 240 (with C- or better); CHEM 337/347 or 232/242. (winter)

BIOL 470   **General Ecology** 5

Study of the interactions between organisms in biological communities and the relationship of biological communities to the environment. Topics include: population growth and regulation, competition and predation, community energetics and nutrient cycling, comparative ecosystem analysis, and the evolution of ecosystems. Laboratory exercises include: field sampling techniques, experimental population manipulations, and ecosystem modeling. Four lecture and three laboratory hours per week. One weekend field trip. Prerequisites: MATH 120; BIOL 161/171, 162/172, 163/173 (all with C- or better). Recommended: BIOL 235 or BIOL 252; PSYC 201. (fall, spring)

BIOL 485   **Cell Biology** 5

Cellular structure and function from a molecular approach. Topics include: membrane transport, cell division, protein synthesis and secretion, cell communication, the cytoskeleton, and cell motility. Emphasis on biochemical laboratory techniques. Four lecture hours and three laboratory hours per week. Prerequisites: BIOL 161/171, 162/172, 163/173 (all with C- or better); BIOL 240 (with C- or better) CHEM 337/347 or 232/242. (fall, winter, spring)

BIOL 487   **Biology Senior Synthesis: Independent Experience** .... 1 to 4

Gives students the opportunity to integrate their liberal arts background from the core with studies in their major. Varying with individual the student's needs, it may involve independent laboratory or field research, library research, or practical work experience. A written project proposal and final report are required. A minimum of two credits is required of all biology majors. Prerequisites: senior standing in biology major or permission of chair. (fall or winter)

BIOL 488   **Biology Senior Synthesis: Seminar** 1

Follows BIOL 487. Each student orally presents the results of his/her independent experience to students and faculty in the Biology Department. Prerequisites: senior standing, BIOL 487. (spring)

BIOL 491-493   **Special Topics** .... 1 to 5

BIOL 496   **Independent Study** .... 1 to 5

BIOL 497   **Directed Reading** .... 1 to 5

BIOL 498   **Directed Research** .... 1 to 5

BIOL 499   **Undergraduate Research** .... 1 to 5

Literature and laboratory investigation of a basic research problem. Preparation of a written report. N grade option approved for research project. Prerequisite: permission of chair. (fall, winter, spring)

Chemistry

David L. Thorsell, PhD, Chair

Objectives

The Chemistry Department has a strong student-centered chemistry program focused on skills and practices that promote career and personal development. The faculty is committed to innovative teaching methods and providing collaborative research experience for all interested students. Recently remodeled research laboratories and new equipment, including a 400MHz NMR spectrometer, provide an excellent environment for students to engage in undergraduate research projects. Through the promotion of undergraduate research opportunities, the department encourages one of the most effective methods of learning chemistry and building skills, confidence and résumés for later professional goals.

Programs offered by the Chemistry Department are designed to prepare the student for professional work in the various fields of basic and applied chemistry. The bachelor of science in chemistry or bachelor of science in biochemistry degree is recommended to students who wish to prepare themselves for graduate studies in chemistry, biochemistry, medical/dental school or for work in the chemical or biochemical industry. Both of these degrees have options for certification by the American Chemical Society. Some additional courses are required to meet the certification requirements.

The bachelor of arts degree is recommended for those desiring a solid foundation in chemistry along with greater freedom of choice for elective courses from programs such as education, business, engineering, or other fields within the university.

Degrees Offered

Bachelor of Arts
Bachelor of Science in Chemistry (and American Chemical Society certified option)
Bachelor of Science in Biochemistry (and American Chemical Society certified option)

Majors Offered

Chemistry
Chemistry with specialization in Humanities for Teaching
Biochemistry

Minor Offered

Chemistry

Bachelor of Arts
Major in Chemistry

In order to earn the bachelor of arts degree with a major in chemistry, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120   **Introduction to Literature**..5
Fine Arts (one approved 5 credit course; see course descriptions)...........................5
PHIL 220   **Philosophy of the Human Person**..5
Social Science I 5
Social Science II (different discipline from Social Science I)....................................5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division)..5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   ....**3 to 5**
Senior Synthesis   ....***3 to 5**

*Major requirement.

NOTE: The senior synthesis core requirement for the bachelor of arts degree with a chemistry major is CHEM 488, 489 and 1 to 3 credits of CHEM 499 or 1 credit of CHEM 490.

II. Major Program Requirements

47 credits in chemistry, including:

CHEM 121	**General Chemistry I**	**4**
CHEM 131	**General Chemistry Lab I**	**1**
CHEM 122	**General Chemistry II**	**4**
CHEM 132	**General Chemistry Lab II**	**1**
CHEM 123	**General Chemistry III**	**4**
CHEM 133	**General Chemistry Lab III**	**1**
CHEM 231	**Fundamental Organic Chemistry I**	**4**
CHEM 241	**Fundamental Organic Chemistry Lab I**.............................	**2**
CHEM 232	**Fundamental Organic Chemistry II**	**4**
CHEM 242	**Fundamental Organic Chemistry Lab II**............................	**2**
CHEM 319	**Quantitative Analysis**...	**5**
CHEM 361	**Physical Chemistry II**..	**3**
CHEM 371	**Physical Chemistry Lab I**	**2**

Choose 10 credits from among the following electives...10

CHEM 260	**Laboratory Safety (2)**
CHEM 360	**Physical Chemistry I (3)**
CHEM 362	**Physical Chemistry III (3)**
CHEM 372	**Physical Chemistry Lab II (2)**
CHEM 415	**Advanced Inorganic Chemistry (3)**
CHEM 425	**Synthetic Inorganic Chemistry Lab (2)**
CHEM 426	**Instrumental Analysis (5)**
CHEM 436	**Advanced Organic Chemistry (3)**
CHEM 454	**Biochemistry I (3)**
CHEM 455	**Biochemistry II (2)**
CHEM 456	**Biochemistry III (3)**
CHEM 464	**Biochemistry Lab I (2)**
CHEM 465	**Biochemistry Lab II (1)**
CHEM 499	**Undergraduate Research (1 to 3)**

and special topics or independent study courses.

III. Other Major Department Requirements

MATH 134	Calculus I	5
MATH 135	Calculus II	5
MATH 136	Calculus III	5
MATH 232	Multivariable Calculus	3

Choose physics series a or b 15

a. PHYS 105	Mechanics	
PHYS 106	Waves, Sound, Electricity and Magnetism	
PHYS 107	Thermodynamics, Optics and Modern Physics	
b. PHYS 121	Mechanics	
PHYS 122	Electricity and Magnetism	
PHYS 123	Waves and Optics	

Bachelor of Arts
Major in Chemistry
Specialization in Humanities for Teaching

In order to earn the bachelor of arts degree with a major in chemistry and specialization in humanities in teaching, students must complete a minimum of 180 credits with a cumulative grade point of 2.50 and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150	Composition: Language and Thought	5
HUMT 151	Composition: Language and the Arts	5
HUMT 152	Logic, Ethics, and Discernment	5
HUMT 161	Humanities: Introduction to Tutoring	2
HUMT 162	Humanities: Introduction to Tutoring	1
HUMT 163	Humanities: Introduction to Tutoring	1
HUMT 171	Proseminar: Humanistic Foundations of Education	5
HUMT 180	Socio-Cultural Transformations I	5
HUMT 181	Socio-Cultural Transformations II	5
HUMT 182	Socio-Cultural Transformations III	5
HUMT 273	Seminar on Secondary Education	5
HUMT 274	Supervised Internship in Secondary Education	5
HUMT 301	Perspectives on the Person I	5
HUMT 302	Perspectives on the Person II	5
HUMT 371	Education and the Polity	5
HUMT 372	Leadership and Teaching	5
HUMT 380	Cultural Interface	5
HUMT 400	Seminar on Contemporary Problems	5
HUMT 471	Jesuit Education	5
HUMT 472	Jesuit Education Practicum	5
CISS 120	Poverty in America	5

II. Major Program Requirements

CHEM 121/131	General Chemistry I	5
CHEM 122/132	General Chemistry II	5
CHEM 123/133	General Chemistry III	5

CHEM 231/241	**Fundamental Organic Chemistry I**	6
CHEM 232/242	**Fundamental Organic Chemistry II**	6
CHEM 319	**Quantitative Analysis**	5
CHEM 361	**Physical Chemistry II**	3
CHEM 371	**Physical Chemistry Lab I**	2
CHEM 260	**Laboratory Safety**	2
CHEM 454	**Biochemistry I**	3
CHEM 488/489	**Senior Synthesis**	3

Choose 5 credits from the following electives:..5

CHEM 360	**Physical Chemistry I (3)**
CHEM 362	**Physical Chemistry III (3)**
CHEM 372	**Physical Chemistry Lab (2)**
CHEM 415	**Advanced Inorganic Chemistry (3)**
CHEM 425	**Synthetic Inorganic Chemistry Lab (2)**
CHEM 426	**Instrumental Analysis (5)**
CHEM 436	**Advanced Organic Chemistry (3)**
CHEM 455	**Biochemistry II (2)**
CHEM 456	**Biochemistry III (3)**
CHEM 464	**Biochemistry Lab I (2)**
CHEM 465	**Biochemistry Lab II (1)**
CHEM 499	**Undergraduate Research (1 to 3)**

III. Other Major Department Requirements

BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3

Choose option a or b..15

a. PHYS 105	**Mechanics**	
PHYS 106	**Waves, Sound, Electricity and Magnetism**	
PHYS 107	**Thermodynamics, Optics and Modern Physics**	
b. PHYS 121	**Mechanics**	
PHYS 122	**Electricity and Magnetism**	
PHYS 123	**Waves and Optics**	

NOTE: For a secondary endorsement in general science, 5 credits of earth science is required.

Bachelor of Science in Chemistry

In order to earn the bachelor of science in chemistry degree, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

| HIST 120 | **Origins of Western Civilization** | |
| **HIST 121** | **Studies in Modern Civilization** | |

ENGL 120   **Introduction to Literature**..5
Fine Arts (one approved 5 credit course; see course descriptions)...........................5
PHIL 220   **Philosophy of the Human Person**...5
Social Science I 5
Social Science II (different discipline from Social Science I)................................5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division)...5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   ....**3 to 5**
Senior Synthesis (CHEM 488, 489, and 499 required) ....***3 to 5**

*Major requirement.

II. Major Requirements

60 credits in chemistry, including:

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
CHEM 122	**General Chemistry II**	4
CHEM 132	**General Chemistry Lab II**	1
CHEM 123	**General Chemistry III**	4
CHEM 133	**General Chemistry Lab III**	1
CHEM 319	**Quantitative Analysis**	5
CHEM 335	**Organic Chemistry I**	3
CHEM 345	**Organic Chemistry Lab I**	2
CHEM 336	**Organic Chemistry II**	3
CHEM 346	**Organic Chemistry Lab II**	2
CHEM 337	**Organic Chemistry III**	4
CHEM 347	**Organic Chemistry Lab III**	2
CHEM 360	**Physical Chemistry I**	3
CHEM 361	**Physical Chemistry II**	3
CHEM 371	**Physical Chemistry Lab I**	2
CHEM 362	**Physical Chemistry III**	3
CHEM 372	**Physical Chemistry Lab II**	2
CHEM 426	**Instrumental Analysis**	5
CHEM	**Electives (400 level)**	6

III. Other Major Department Requirements

MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
PHYS 121	**Mechanics**	5
PHYS 122	**Electricity and Magnetism**	5
PHYS 123	**Waves and Optics**	5

NOTE: 1. For the American Chemical Society certified degree option, the 6-credit elective, above under II, must be replaced by CHEM 415, CHEM 425, CHEM 454, CHEM 464, and three additional credits of

approved advanced work in chemistry (CHEM 499 is acceptable here). 2. For students planning graduate work, any of the courses, MATH 233, MATH 234, or CHEM 415, 425, 436, 454, 455, 456, 464, and 465 are strongly recommended as electives. 3. The senior synthesis core requirement for the bachelor of science degree in chemistry is CHEM 488, 489 and 1 to 3 credits of CHEM 499.

Bachelor of Science in Biochemistry

In order to earn the bachelor of science in biochemistry degree, students must complete a minimum of 180 quarter credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**	5

Fine Arts (one approved 5 cr. course; see course descriptions) 5

PHIL 220	**Philosophy of the Human Person**	5
Social Science I		5

Social Science II (different discipline from Social Science I) 5

Theology and Religious Studies Phase II (200-299) 5

Ethics (upper division) 5

Theology and Religious Studies Phase III (300-399) 5

Interdisciplinary		**3 to 5**

Senior Synthesis (CHEM 488, 489, and 499 required) ....*3 to 5

*Major requirement

II. Major Requirements

60 credits of chemistry, including:

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
CHEM 122	**General Chemistry II**	4
CHEM 132	**General Chemistry Lab II**	1
CHEM 123	**General Chemistry III**	4
CHEM 133	**General Chemistry Lab III**	1
CHEM 215	**Fundamental Inorganic Chemistry**	3
CHEM 319	**Quantitative Analysis**	5
CHEM 335	**Organic Chemistry I**	3
CHEM 345	**Organic Chemistry Lab I**	2
CHEM 336	**Organic Chemistry II**	3
CHEM 346	**Organic Chemistry Lab II**	2
CHEM 337	**Organic Chemistry III**	4
CHEM 347	**Organic Chemistry Lab III**	2
CHEM 361	**Physical Chemistry II**	3
CHEM 371	**Physical Chemistry Lab I**	2
CHEM 454	**Biochemistry I**	3

CHEM 455	**Biochemistry II**	2
CHEM 456	**Biochemistry III**	3
CHEM 464	**Biochemistry Lab 1**	2
CHEM 465	**Biochemistry Lab II**	1

Choose option a or b... 5
a. CHEM 426   **Instrumental Analysis (5)**
b. CHEM 362   **Physical Chemistry III (3)**
   CHEM 372   **Physical Chemistry Lab II (2)**

III. Other Major Department Requirements

| BIOL 161 | **Biology I: Molecular and Cellular Biology** | 4 |
| BIOL 171 | **Biology I Lab** | 1 |

Choose 10 credits from the following six courses: 10
BIOL 163   **Biology III: Physiology and Development (4)**
BIOL 173   **Biology III Lab (1)**
BIOL 240   **Genetics (5)**
BIOL 300   **Microbiology (5)**
BIOL 440   **Molecular Genetics (5)**
BIOL 485   **Cell Biology (5)**

MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
PHYS 121	**Mechanics**	5
PHYS 122	**Electricity and Magnetism**	5
PHYS 123	**Waves and Optics**	5

NOTE: 1. For the American Chemical Society certified degree option, the student must take CHEM 425 and both CHEM 426 and CHEM 362/372. CHEM 360 and 362/372 are highly recommended electives for students planning graduate work in biochemistry. 2. The senior synthesis core requirement for the bachelor of science degree in biochemistry is CHEM 488, 489 and 1 to 3 credits of CHEM 499.

Minor in Chemistry

In order to earn a minor in chemistry, students must complete 35 credits in chemistry, including:

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
CHEM 122	**General Chemistry II**	4
CHEM 132	**General Chemistry Lab II**	1
CHEM 123	**General Chemistry III**	4
CHEM 133	**General Chemistry Lab III**	1
CHEM 319	**Quantitative Analysis**	5
CHEM Elective (200-level or above)		*5
Organic Chemistry (200-level or above)		10

*1 credit from CHEM/CRJS 480 Forensic Science may apply towards the CHEM elective requirement in the minor.

See policy for minors (84-1) for more information.

Chemistry Courses

Credit may be received for only one of each of the following sets of courses: CHEM 231/330/335; 232/331/336; 241/345; 242/346. A student who completes CHEM 231 with a grade of B or better may enroll in CHEM 336 with the instructor permission.

All prerequisite courses must be completed with a grade of C- or better for the prerequisite to be fulfilled.

CHEM 101   Introductory General Chemistry **5**
Survey of inorganic chemistry, treating the basic principles and descriptive material relevant to the health sciences. Core lab science course. Four lecture and three laboratory hours per week. Prerequisite: MATH 107 or 110, or placement at a higher math level. (fall, winter, spring)

CHEM 102   Introductory Organic and Biochemistry... **5**
Organic chemistry and introduction to biochemistry with application to the health sciences. Four lecture and three laboratory hours per week. Prerequisite: CHEM 101 or equivalent.

CHEM 104   Chemistry, Food and Nutrition.. **5**
Basic general and organic chemistry in the contexts of food and nutrition, including atoms and molecules, ionic and molecular substances, chemical reactions, minerals, vitamins, fats and oils, lipids, carbohydrates, proteins, and the chemistry of cooking food. Core lab science. (spring)

CHEM 105   Introduction to Environmental Chemistry **5**
Basic chemistry in the context of environmental processes, such as greenhouse gases, global warming, ozone, energy production and consumption, and groundwater contamination. Evaluation of the impact modern human life has upon the environment, and assessment of current topical literature. Fulfills core lab science requirement.

CHEM 121   General Chemistry I **4**
Atomic and molecular structure, oxidation-reduction reactions, mass relationships, periodic properties, acids, bases ionic reactions. Five lectures per week. Prerequisites: CHEM 101 or high school chemistry and placement into MATH 120 or higher. Co-requisite: CHEM 131. (fall, winter)

CHEM 122   General Chemistry II **4**
Thermochemistry, gases, solutions, equilibria. Four lectures per week. Prerequisite: CHEM 121 and MATH 120 or placement at a higher math level. Co-requisites: CHEM 132 . (winter, spring)

CHEM 123   General Chemistry III **4**
Thermodynamics, kinetics, electrochemistry, nuclear chemistry, chemistry of metals and nonmetals. Four lectures per week. Prerequisite: CHEM 122. Co-requisite: CHEM 133. (spring, summer)

CHEM 131   General Chemistry Lab I **1**
CHEM 132   General Chemistry Lab II **1**
Introduction to basic laboratory procedures and safety, practice in modes of scientific inquiry, including observation, measurement, data collection, interpretation and evaluation of results, and reporting. Three hours per week. Prerequisite: CHEM 131 for 132. Co-requisites: CHEM 121 for 131; 122 for 132. (131, fall, winter; 132, winter, spring)

CHEM 133   General Chemistry Lab III **1**
Introduction to qualitative chemical analysis on a semimicro scale. Experimentation in the chemistry of ionic systems and basic quantitative analytical methods. Four hours per week. Co-requisite: CHEM 123; Prerequisite: CHEM 132. (spring, summer)

CHEM 215   Fundamental Inorganic Chemistry.. **3**
Foundational topics in inorganic chemistry with emphasis on coordination chemistry, solid state chemistry, inorganic descriptive chemistry and bioinorganic chemistry. Prerequisite: CHEM 123. (spring)

CHEM 231   **Fundamental Organic Chemistry I** 4

CHEM 232   **Fundamental Organic Chemistry II** 4

Structure, bonding, nomenclature, reactions, and synthesis of organic compounds: I) alkanes, alkenes, alkynes, alkyl halides, aromatic, and heteroaromatic compounds; II) alcohols, ethers, phenol, thiols, aldehydes, ketones, carboxylic acids and derivatives, amines, carbohydrates, amino acids, and proteins. Spectroscopic applications. Each is four lecture hours per week.Consult advisor for adequacy of 200 level organic chemistry series to satisfy admission requirements for specific medical schools. Prerequisites: CHEM 123 for 231; 231 for 232. (231 winter; 232 spring)

CHEM 241   **Fundamental Organic Chemistry Lab I** 2

CHEM 242   **Fundamental Organic Chemistry Lab II** 2

Techniques used in synthesis, isolation, and identification of organic compounds. Each is four laboratory hours per week. Co-requisite: 231 for 241; 232 for 242. Prerequisite: CHEM 133 for 241; 241 for 242. (241 winter; 242 spring)

CHEM 260   **Laboratory Safety** 2

Important aspects of hazardous chemicals and laboratory safety, including pertinent laws and regulations. Establishing and maintaining a safe working environment in the laboratory. Prerequisite: One quarter of general chemistry. (winter)

CHEM 291-293   **Special Topics** .... 1 to 5

CHEM 296   **Directed Study** .... 1 to 5

CHEM 319   **Quantitative Analysis** 5

Theory, methods, and techniques of volumetric, electro-analytical, spectrophotometric, chromatographic and micro-analytical procedures in quantitative analysis; introductory statistics. Two lecture and six laboratory hours per week. Prerequisites: CHEM 123, 133 and junior level standing or permission of chair. (fall, winter)

CHEM 330   **Organic Chemistry IA** 4

CHEM 331   **Organic Chemistry IIA** 4

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds and applications. Emphasizes the use of kinetic and non-kinetic methods in the determination of reaction mechanisms, and qualitative structure-reactivity correlations. IA: Hydrocarbons, alkyl halides, ethers and alcohols, spectroscopy. IIA: Aromatics, aldehydes and ketones, carboxylic acids and their derivatives, amines, carbohydrates and lipids. Prerequisites: one year of general chemistry with laboratory for 330; CHEM 330 or one semester of organic chemistry for 331. Co-requisites: CHEM 345 (2 cr) Organic Chemistry Laboratory I for 330; CHEM 346 (2 cr) Organic Chemistry Laboratory II for 331. Offered summer only, 330 in first four weeks and 331 in second four weeks.

CHEM 332   **Organic Chemistry IIIA** 2

The chemistry of carbanions, amino acids, proteins and nucleic acids. Offered concurrently with CHEM 337 in spring quarter. A new course for students wanting credit for the 300-level organic series. NOTE: CHEM 330-332 are equivalent to CHEM 335-337. Prerequisite: CHEM 331.

CHEM 335   **Organic Chemistry I** 3

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; hydrocarbons and alkyl halides. Four lectures per week. Prerequisite: CHEM 123. (fall)

CHEM 336   **Organic Chemistry II** 3

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; spectroscopy, aromatic and oxy-organic compounds. Four lectures per week. Prerequisite: CHEM 335. (winter)

CHEM 337   **Organic Chemistry III** **4**

Structural theory, functional groups, nomenclature, stereochemistry, kinetics and thermodynamics of organic reactions, syntheses of organic compounds, and applications; amines, phenols and aryl halides, carbanions and the structure and chemistry of biomolecules. Four lectures per week. Prerequisite: CHEM 336. (spring)

CHEM 345   **Organic Chemistry Lab I** **2**

Theory and practice of laboratory techniques; experimental study of properties of organic compounds; introduction to organic synthesis. Four hours per week. Prerequisite: CHEM 133. Co-requisite: CHEM 335. (fall)

CHEM 346   **Organic Chemistry Lab II** **2**

Application of laboratory techniques in simple and multistep syntheses; qualitative and quantitative measurements of properties of organic compounds; determination of kinetic and thermodynamic parameters. Four hours per week. Prerequisite: CHEM 345. Co-requisite: CHEM 336. (winter)

CHEM 347   **Organic Chemistry Lab III** **2**

Instrumental and classical qualitative techniques applied to the identification of organic compounds. Five hours per week. Prerequisite: CHEM 346 (or 242) Co-requisite: CHEM 337 (or prerequisite 232). (spring)

CHEM 360   **Physical Chemistry I** **3**

CHEM 361   **Physical Chemistry II** **3**

CHEM 362   **Physical Chemistry III** **3**

1. Quantum chemistry and spectroscopy. 2. States of matter, thermodynamics, equilibrium, kinetics. 3. Theory of reaction rates, thermodynamics of solutions, phase equilibrium, electrochemistry, photochemistry and statistical thermodynamics. Three lectures per week. 1 may be taken either before or after 2 and 3. Prerequisites: CHEM 123, CHEM 133, MATH 232, and one year of physics for CHEM 360 and CHEM 361; CHEM 361 for CHEM 362. (360 fall, 361 winter, 362 spring)

CHEM 371   **Physical Chemistry Laboratory I** **2**

CHEM 372   **Physical Chemistry Laboratory II** **2**

Quantitative measurements of physical chemical phenomena, detailed data analysis, and evaluation. Four laboratory hours per week. Prerequisites: CHEM 319 for CHEM 371; CHEM 371 for CHEM 372. CHEM 361 is co-requisite or prerequisite for CHEM 371; CHEM 362 is a co-requisite or prerequisite for CHEM 372. (371 winter, 372 spring)

CHEM 391-393   **Special Topics** .... **1 to 5**

CHEM 396   **Directed Study** .... **1 to 5**

CHEM 415   **Advanced Inorganic Chemistry** **3**

Advanced topics in inorganic chemistry, with particular attention to the transition metals, including their compounds, properties and biochemistry. Prerequisite: CHEM 361. (spring)

CHEM 425   **Synthetic Inorganic Chemistry Laboratory** **2**

Synthesis and characterization of inorganic compounds involving a variety of laboratory techniques and instrumentation, including, high temperature, vacuum line or inert atmosphere and nonaqueous solvent syntheses and characterization by NMR, FTIR, conductivity, GC, magnetic susceptibility and UV-Vis spectroscopy. Four laboratory hours per week. Prerequisite: CHEM 319. Co-requisite: CHEM 415. (spring)

CHEM 426   **Instrumental Analysis** **5**

Theory and techniques of instrumental methods representative of spectrometric, electroanalytical and chromatographic techniques. Two lecture and two four-hour laboratory periods per week. Prerequisites: CHEM 319, 361. (spring)

CHEM 436   **Advanced Organic Chemistry** **3**

Advanced topics in organic chemistry. Directed reading and/or lectures. Prerequisite: CHEM 361 and one year of organic chemistry. (fall)

CHEM 454   **Biochemistry I** **3**
Structure and function of amino acids, proteins, lipids, carbohydrates and nuclear acids. Kinetics and mechanisms of enzyme action. Molecular aspects of cell biology and function. Prerequisites: BIOL 161 and 171 or permission of chair; CHEM 232 or CHEM 337. (fall)

CHEM 455   **Biochemistry II** **2**
Mechanistic study of the biosynthesis of nucleic acids and proteins using directed readings. Two lecture hours per week. Prerequisite: CHEM 454. (winter)

CHEM 456   **Biochemistry III** **3**
Intermediary metabolism: A study of the metabolism of carbohydrates, lipids, amino acids, and nucleic acids with emphasis on enzymology, thermodynamics, metabolic control mechanisms, and integration of control between metabolic pathways. Prerequisite: CHEM 454. (spring)

CHEM 464   **Biochemistry Lab I** **2**
Current laboratory methods in biochemistry including amino acid analysis, enzyme kinetics, protein purification techniques, gel electrophoresis, immunoblotting, and fatty acid analysis. Prerequisites: CHEM 242 or CHEM 347; CHEM 319. Co-requisite: CHEM 454. (fall)

CHEM 465   **Biochemistry Lab II** **1**
Methods of biotechnology including the polymerase chain reaction. Three laboratory hours per week. Prerequisites: CHEM 454 and CHEM 464. Co-requisite: CHEM 455. (winter)

CHEM 480-483   **Interdisciplinary Core Course** .... **3 to 5**
Title and content change each term.

CHEM 488   **Senior Synthesis Seminar I** **1**
Initiation of a research project. Includes online chemical literature search, project formulation, annotated bibliography and preparation of a brief research proposal. Required as part of the senior synthesis core requirement for chemistry, biochemistry and medical technology majors. Prerequisites: CHEM 232 or CHEM 336, minimum 10 credits of chemistry at SU or permission of chair. (fall)

CHEM 489   **Senior Synthesis Seminar II** **1**
Presentation of the senior synthesis project. Includes oral and written presentation of the senior synthesis project according to the American Chemical Society guidelines for undergraduate research presentations. Required as part of the senior synthesis core requirement for chemistry, biochemistry and medical technology majors. Prerequisite: CHEM 488. (spring)

CHEM 490   **Senior Synthesis** .... **1 to 3**
Capstone activity, including in-depth investigation of scientific or clinical topics. Prerequisites: CHEM 488 and permission of chair.

CHEM 491-493   **Special Topics** .... **1 to 5**
CHEM 496   **Independent Study** .... **1 to 5**
CHEM 497   **Directed Reading** .... **1 to 5**
CHEM 498   **Directed Research** .... **1 to 5**
Permission of chair required.

CHEM 499   **Undergraduate Research** .... **1 to 6**
Literature and laboratory investigation of a research problem in collaboration with a chemistry department faculty member or approved external advisor. A minimum of four laboratory hours per week per credit. Prerequisite: CHEM 488 permission of chair.

Civil and Environmental Engineering

Phillip Thompson, PhD, PE, Chair

Objectives

Civil engineering is the knowledge of mathematical and physical sciences to provide structures, improve and protect the environment, and provide facilities for community living, industry, and transportation for the use of mankind.

The mission of the Civil and Environmental Engineering Department is to provide educational opportunities for students seeking to enter the civil engineering profession, so that they can achieve competence in the field while recognizing their social responsibilities. The program provides a strong foundation in the areas of mathematics, basic and engineering sciences, and the humanities and social sciences. It encourages further self development and life-long intellectual achievement. The program seeks to build student skills in written and oral communication, and a sense of poise and professionalism.

Analysis and design courses in the fields of environmental, geotechnical, hydraulic, structural, and water resources engineering are offered in addition to preparatory courses in sciences and basic mechanics. A broad base of theory is provided, along with its application to current practices of the profession.

The program objectives of the civil engineering program are to prepare graduates in the following areas:

- **Technical Proficiency:** Ability to apply a technical core of knowledge in mathematics, science, and civil engineering, which includes understanding the fundamentals of several recognized civil engineering areas (e.g., environmental, geotechnical, structural, and water resources engineering).

- **Communications Skills:** Ability to communicate effectively including writing, speaking, listening, and observing and to use graphics, the worldwide web, and other communication tools.

- **Professional Skills:** Ability to use the broad spectrum of skills needed in professional practice including teamwork, leadership, and project and business management, and an understanding of professional ethics, contemporary issues, safety, and economics.

- **Personal Breadth:** Understanding of non-technical aspects of engineering, including ethical considerations, concern for society and the environment, and multi-cultural perspectives, as well as a commitment to life-long learning and service to the professional and civic communities.

Degree Offered
Bachelor of Science in Civil Engineering

Majors Offered
Civil Engineering
Civil Engineering with specialization in Environmental Engineering

Minor Offered
Environmental Engineering

Departmental Requirements

In addition to the prerequisites, departmental candidacy in one of the engineering departments is required for entry into 300- and 400-level courses. Candidacy is achieved by successfully completing all required 100- and 200-level engineering, chemistry, computer science, mathematics, and physics courses with a combined grade point average of at least 2.50, as well as ENGL 110. Only courses graded C (2.00) or higher may be transferred into the department to offset degree requirements.

For graduation, a minimum 2.50 cumulative grade point average is required, as well as a minimum 2.50 average in Seattle University classes in science, computer science, physics, mathematics, and engineering courses.

Taking the Washington state Fundamentals of Engineering (FE) examination is required for the degree. The civil engineering program is accredited by the Engineering Accreditation Commission of ABET, formerly known as the Accreditation Board for Engineering and Technology.

Bachelor of Science in Civil Engineering
Major in Civil Engineering

In order to earn the bachelor of science in civil engineering degree, students must complete a minimum of 192 credits including 45 credits in core curriculum, with a cumulative and major/department grade point average of 2.50, including the following:

I. Core Curriculum Requirements

Students majoring in civil engineering must earn a minimum of 45 credits in the core curriculum.

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	5
PHIL 220	**Philosophy of the Human Person**	5

Social Science I (not economics) 5
Social Science II satisfied by CEEGR 302
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied within major.
Senior synthesis filled by CEEGR 487, 488, 489.

II. Major Requirements

83 credits, including:

CEEGR 105	**Civil Engineering Graphics and Communication**	3
CEEGR 221	**Mechanics of Materials I**	4
CEEGR 222	**Mechanics of Materials Lab I**	2
CEEGR 302	**Engineering Economy**	3
CEEGR 311	**Engineering Measurements**	4
CEEGR 323	**Mechanics of Materials II**	5
CEEGR 331	**Fluid Mechanics**	4
CEEGR 335	**Applied Hydraulics**	5
CEEGR 337	**Fluids Lab**	1

CEEGR 342	**Environmental Engineering Chemistry**	4
CEEGR 351	**Engineering Geology**	4
CEEGR 353	**Soil Mechanics**	5
CEEGR 371	**Water Resources I**	3
CEEGR 445	**Structural Mechanics**	5
CEEGR 473	**Principles of Environmental Engineering**	5
CEEGR 487	**Engineering Design I**	4
CEEGR 488	**Engineering Design II**	4
CEEGR 489	**Engineering Design III**	4

Choose elective sequence a or b:...10

a. CEEGR 447	**Structural Design I**
CEEGR 449	**Structural Design II**
b. CEEGR 474	**Water Supply and Wastewater Engineering**
CEEGR 475	**Hazardous Waste Engineering**

Choose one of the following five courses:..4

CEEGR 425	**Transportation Engineering**
CEEGR 455	**Foundation Design**
CEEGR 472	**Water Resources II**
CEEGR 476	**Environmental Law and Impact Studies**
CEEGR 486	**Green Engineering**

III. Other Major Department Requirements

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
MEGR 210	**Statics**	4
MEGR 230	**Dynamics**	4
MEGR 281	**Engineering Methods**	4
MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
MATH 233	**Linear Algebra**	3
MATH 234	**Differential Equations**	4

Choose one of the following two courses: 5

MATH 244	**Probability and Statistics**
MATH 351	**Probability**

PHYS 121	**Mechanics**	5
PHYS 122	**Electricity and Magnetism**	5
PHYS 123	**Waves and Optics**	5
Elective	**(CEEGR 100 recommended)**	2

NOTE: Fundamentals of Engineering (FE) examination is required for graduation.

Bachelor of Science in Civil Engineering
Major in Civil Engineering with a
Specialization in Environmental Engineering

In order to earn the bachelor of science in civil engineering degree with a specialization in environmental engineering, students must complete a minimum of 45 credits in the core curriculum and 192 credits total. A cumulative 2.50 grade point average is required, in addition to a 2.50 average in major/department requirements, including the following:

I. Core Curriculum Requirements

ENGL 110   **College Writing: Inquiry and Argument** 5
PHIL 110   **Introduction to Philosophy and Critical Thinking** 5

Choose one of the following two courses: 5
HIST 120   **Origins of Western Civilization**
HIST 121   **Studies in Modern Civilization**

ENGL 120   **Introduction to Literature** 5
PHIL 220   **Philosophy of the Human Person** 5
Social Science I (not economics) 5
Social Science II satisfied by CEEGR 302
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied within major.
Senior synthesis filled by CEEGR 487, 488, 489.

Students majoring in civil engineering with an environmental engineering specialty must earn a minimum of 45 credits in the core curriculum. See detailed core curriculum information in this *Bulletin*.

II. Major Requirements

78 credits, including:
CEEGR 105   **Civil Engineering Graphics and Communication**...................................... 3
CEEGR 221   **Mechanics of Materials I**.. 4
CEEGR 222   **Mechanics of Materials Lab I**.. 2
CEEGR 302   **Engineering Economy** 3
CEEGR 311   **Engineering Measurements** 4
CEEGR 331   **Fluid Mechanics** 4
CEEGR 335   **Applied Hydraulics**... 5
CEEGR 337   **Fluids Lab**.. 1
CEEGR 341   **Biological Principles for Environmental Engineers**................................. 5
CEEGR 342   **Environmental Engineering Chemistry** 4
CEEGR 351   **Engineering Geology** 4
CEEGR 353   **Soil Mechanics** 5
CEEGR 371   **Water Resources I** 3
CEEGR 473   **Principles of Environmental Engineering** 5
CEEGR 474   **Water Supply and Wastewater Engineering** 5
CEEGR 475   **Hazardous Waste Engineering** 5
CEEGR 487   **Engineering Design I**.. 4
CEEGR 488   **Engineering Design II**... 4
CEEGR 489   **Engineering Design III** 4

Choose one of the following five courses:.. 4

CEEGR 425	**Transportation Engineering**	
CEEGR 455	**Foundation Design**	
CEEGR 472	**Water Resources II**	
CEEGR 476	**Environmental Law and Impact Studies**	
CEEGR 486	**Green Engineering**	

III. Other Major Department Requirements

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
MEGR 210	**Statics**	4
MEGR 230	**Dynamics**	4
MEGR 281	**Engineering Methods**	4
MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
MATH 233	**Linear Algebra**	3
MATH 234	**Differential Equations**	4

Choose one of the following two courses: 5

MATH 244	**Probability and Statistics**	
MATH 351	**Probability**	

PHYS 121	**Mechanics**	5
PHYS 122	**Electricity and Magnetism**	5
PHYS 123	**Waves and Optics**	5

Choose one of the following two options: 5

a. BIOL 101	**Principles of Biology**	
b. BIOL 161	**Biology I: Molecular and Cellular Biology**	
BIOL 171	**Biology I Lab**	

Elective	**(CEEGR 100 recommended)**	2

NOTE: Fundamentals of Engineering (FE) examination is required for graduation.

Minor in Environmental Engineering

To earn a minor in environmental engineering, students must complete a minimum of 30 credits in civil and environmental engineering, including:

CEEGR 341	**Biological Principles for Environmental Engineers**	5
CEEGR 342	**Environmental Engineering Chemistry**	4
CEEGR 351	**Engineering Geology**	4
CEEGR 473	**Principles of Environmental Engineering**	5
CEEGR 476	**Environmental Law and Impact Studies**	4
CEEGR 486	**Green Engineering**	4
Approved CEEGR courses (300 or higher)		4

Students majoring in civil engineering are not eligible for this minor. See policy for minors (84-1) for more information.

Civil and Environmental Engineering Courses

CEEGR 100 Introduction to Civil and Environmental Engineering 2
Investigation of some major branches of civil `and environmental engineering at the introductory level. Introduction to the profession through lectures from faculty and practicing civil engineers, field trips to construction sites and design offices and hands-on demonstrations. Research of contemporary and significant civil engineering projects. Recommended for students majoring in civil and environmental engineering. Open to all students wishing to explore the possibilities of civil and environmental engineering as a career. (fall)

CEEGR 105 Civil Engineering Graphics and Communication...................................... 3
An introduction into the drawing production and communication process in civil engineering. Sketching, drawing interpretation, plan views, sections, elevations, dimensioning, abbreviations, and professional written communication. Development of drawing packages using AutoCAD with emphasis on professional drawing production. Three two-hour sessions per week. Laboratory. (fall, spring)

CEEGR 221 Mechanics of Materials I... 4
Mechanics of solid deformable bodies; relationships between the external forces acting on elastic bodies and the stresses and deformations produced. Members subjected to tension, compression, flexure, and torsion. Four lecture hours per week. Prerequisites: MEGR 210, MATH 136. (fall, spring)

CEEGR 222 Mechanics of Materials Laboratory I....................................... 2
Laboratory experiments on the mechanics of solid deformable bodies and the relationships between tension, compression, flexure, and torsion. Developing technical report writing skills; use of spreadsheets and computer graphics. Four hours per week. Pre or co-requisite: CEEGR 221. (fall, spring)

CEEGR 291-293 Special Topics 1 to 5

CEEGR 296 Directed Study .... 1 to 5

CEEGR 302 Engineering Economy 3
Elements of immediate and long-term economy of facility design, construction and maintenance; interest rates, present worth and prospective return on investment; depreciation and replacement studies. (fall, winter)

CEEGR 311 Engineering Measurements 4
Introduction to surveying and mapping. Concepts, instruments and practice of engineering measurements, topographic mapping, public land system, boundary surveys, aerial photogrammetry, and the global position system; error adjustment, earthwork, and highway curve design. Three lectures and one laboratory period per week. Prerequisites: MATH 120, 121, and CEEGR 105. (spring)

CEEGR 323 Mechanics of Materials II 5
Continuation of the mechanics of solid deformable bodies. Beam topics, stability of columns, combined stresses and strains, fatigue and energy relationships. Laboratory experiments on the mechanics of solid deformable bodies and the stresses and deformations produced. Improving technical writing skills; use of spreadsheets and computer graphics. Four lecture hours and one three-hour laboratory per week. Prerequisites: C- or better in CEEGR 221, MATH 234. (winter)

CEEGR 325 Applied Engineering Mechanics 3
Advanced topics in mechanics of materials and structural analysis for students not specializing in structures. Combine stress states, calculation of beam deflections, column stability and theories of failure. Three lecture hours per week. Prerequisites: CEEGR 221, MATH 234. (winter)

CEEGR 331   Fluid Mechanics **4**

Fluid properties. Elementary mechanics of incompressible fluids. Hydrostatics and fluid kinematics. Continuity and energy equations. Pump and turbine power calculations. Fluid resistance phenomena and estimations for laminar and turbulent flows. Momentum equation and dynamic forces. Dynamic similitude and hydraulic modeling. Pre or co-requisite: MEGR 230. (fall, winter)

CEEGR 335   Applied Hydraulics **5**

Extension and application of fluid mechanics principles with laboratory. Pipes in series and in parallel. Branching pipes and pipe networks. Pipeline system curves. Basic hydraulic machinery. Analysis of pumping systems. Basic open channel flow. Backwater analysis. Culverts. Four lecture hours and one three-hour laboratory per week. Prerequisite: CEEGR 331. (winter)

CEEGR 337   Fluids Laboratory **1**

Experimental calibration of various flow meters, loss coefficients, and pipe friction factors. Experimental verification of various principles of fluid mechanics. One three-hour laboratory per week. Co-requisite (CEEGR Majors only): CEEGR 331. (fall, winter)

CEEGR 341   Biological Principles for Environmental Engineers **5**

Basic principles of microbiology and biochemistry as applied to environmental control and wastewater treatment. Kinetic and energetic aspects are emphasized. Effects of domestic and industrial water pollution on the biological characteristics of natural waters and aquatic life are studied. Laboratory includes plating techniques, studying biological growth kinetics and advanced genetic techniques such as gene amplification using polymerase chain reaction (PCR). Prerequisite: BIOL 101 or BIOL 161 and 171 or equivalent. (fall)

CEEGR 342   Environmental Engineering Chemistry **4**

Principles of chemical kinetics and thermodynamics applied to fundamental understanding of aqueous environmental samples, including natural waters, wastewaters, and treated waters; factors controlling inorganic and organic chemical concentrations, acid-base equilibria, and absorption phenomena. Prerequisites: CHEM 121, 131, or equivalent. (spring)

CEEGR 351   Engineering Geology **4**

Mineralogy of rocks; types of rocks, their formation, structure and engineering properties; plate tectonics; structural geology; seismicity; introduction to and use of topographic maps, aerial photographs and geologic maps in engineering projects. Geotechnical field exploration techniques. Slope stability issues. Erosional and depositional land forms of rivers and glaciers. Engineering geology in contemporary civil engineering projects. Four lecture hours per week. (fall)

CEEGR 353   Soil Mechanics **5**

Engineering properties and classification of soils; compaction, permeability, effective stress concept, consolidation, settlements and time rate of settlements, shear strength of soils, strength measurements of soils, field investigation. Four lecture hours and one laboratory session per week. Prerequisites: CEEGR 221. Pre- or co-requisite: CEEGR 331. (winter)

CEEGR 371   Water Resources I **3**

Hydrologic data sources, collection, and analysis, including frequency analysis. Precipitation, runoff, evaporation, and transpiration. Analysis of stream flow, hydrographs, flood mitigation, and drainage basins. Prerequisite: CEEGR 331, Co-requisite or prerequisite: MATH 244 or 351. (spring)

CEEGR 391-393   Special Topics .... **1 to 5**

CEEGR 396   Directed Study .... **1 to 5**

CEEGR 425   Transportation Engineering **4**
Introduction to the fundamentals of highway transportation systems. Methods of predicting travel demand and capacity supply. Use of field surveys and statistical representation of traffic characteristics. Urban transportation planning and design. Roadway design. (winter)

CEEGR 445   Structural Mechanics **5**
Classical and matrix methods in structural mechanics. Introduction to finite element analysis, dynamic response of structures, structural idealization and computer modeling. Prerequisite: CEEGR 323. (fall)

CEEGR 447   Structural Design I **5**
CEEGR 449   Structural Design II **5**
Design of structural members and connections. Specific structural design building codes. I. Steel design. II. Reinforced and prestressed concrete design. Prerequisite: CEEGR 445. (447 winter, 449 spring)

CEEGR 455   Foundation Design **4**
Design considerations for foundations. Introduction to Terzaghi's bearing capacity theory and lateral earth pressure theory. Design of shallow and deep foundations. Design of retaining walls, sheet pile walls and anchored retaining structures. Slope stability analysis. Correlation of soil properties based on subsurface exploration results. Prerequisite: CEEGR 353. (spring)

CEEGR 472   Water Resources II **4**
Streamflow routing process. Hydrograph analysis and synthesis. Reservoir capacity, operation, and routing processes. Subsurface hydrology. Well hydraulics. Erosion and sedimentation. Prerequisite: CEEGR 371. (fall)

CEEGR 473   Principles of Environmental Engineering **5**
Introduction to water and wastewater treatment processes, air pollution control and hazardous waste management through the understanding of physical, chemical, and biological processes as well as mass balance analyses. Four lectures and one laboratory or field trip per week. Prerequisites: CHEM 121, 131, CEEGR 342. (fall)

CEEGR 474   Water Supply and Wastewater Engineering **5**
Physical, chemical, and biological process design for water supply and wastewater treatment. Four lectures and one laboratory or field trip per week. Prerequisite: CEEGR 473. (winter)

CEEGR 475   Hazardous Waste Engineering **5**
Explores the fate and transport of hazardous materials in the environment. Regulatory considerations, programmatic criteria and remediation technologies are also evaluated. Prerequisite: CEEGR 473 or instructor permission. (spring)

CEEGR 476   Environmental Law and Impact Studies **4**
Social, economic, and engineering factors involved in environmental regulations. National and regional water policies, programs, and administration. Emphasis on national environmental policy act and its implementation. Terminology of environmental inventory, assessment, and impact statement. Senior standing recommended. (winter)

CEEGR 486   Green Engineering **4**
Introduces principles of green building including the sustainable use of water, energy and materials. Focuses also on the design of alternative energy production systems including solar, wind and microhydro systems for the developing world. Sustainable pollution control technologies for air and water are also examined. Students are required to identify a project that culminates with a final design report and presentation. Pre- or co-requisite: CEEGR 342. (spring)

CEEGR 487   **Engineering Design I**.. **4**

Design process, problem solving and decision making, project planning and scheduling, team dynamics, résumé writing, networking and interviewing skills, interaction with the professional engineering community, developing technical writing and oral communication skills. Engineering proposal preparation for senior capstone project. Prerequisite: senior standing and department permission. (fall)

CEEGR 488   **Engineering Design II**.. **4**

CEEGR 489   **Engineering Design III** **4**

Group design project focusing on the integrative aspects of engineering subject matter. The project should focus on: (1) philosophy of design, a creative approach, and a comprehensive design project; planning, organizing and leading an engineering project, exercising judgment and considering economic factors; and (2) integrated aspects of creative design and analysis; case studies; design of a novel device or system. Two lecture and four design hours per week. The three-course series fulfills the senior synthesis core requirement. Prerequisite: CEEGR 487 for CEEGR 488; CEEGR 488 for CEEGR 489. (488 winter, 489 spring)

CEEGR 491-493   **Special Topics**.. **1 to 5**

CEEGR 496   **Independent Study** .... **1 to 5**

CEEGR 497   **Directed Reading** .... **1 to 5**

CEEGR 498   **Directed Research**.. **1 to 5**

Computer Science/Software Engineering

Richard LeBlanc, PhD, Chair

Objectives

The computer science program seeks to prepare students for careers that require sophisticated programming and computer applications in industrial, scientific, technical or educational settings, and to incorporate into the program the principles and techniques of software engineering. The program provides solid foundations for understanding the changing roles of computers in society and encourages students to apply their knowledge to solving a variety of problems through laboratory and project activities.

Recognizing that different people study computer science for different reasons, the department offers both bachelor of science and bachelor of arts degrees. The bachelor of science in computer science (BSCS) degree program provides a rigorous professional, technical educational background, appropriate for a career in software development or for entry into graduate study in computer science. A general option is available, as well as two specializations, the bachelor of science in computer science with a specialization in mathematics, and the bachelor of science in computer science with specialization in business. These specialized options within the BSCS degree program enable students to develop greater interdisciplinary expertise which will better equip them for jobs demanding such skills in the workplace.

The bachelor of arts (BA) degree program offers a sound foundation in computer science courses, while allowing greater flexibility in determining an area of application of the acquired computing skills. It is an excellent preparation for students interested in professional careers involving computer applications in less technical areas such as business or education.

Both the BSCS and BA degree programs require that all students complete a capstone experience, the year-long senior software engineering project which requires students to work in small groups to complete a substantial software system project, working with a faculty advisor and a sponsoring organization from business or industry. In addition to the bachelor's degree programs, the department offers a computer science minor, as well as computer literacy courses.

Degrees Offered
Bachelor of Arts
Bachelor of Science in Computer Science
Master of Software Engineering—See the *Graduate Bulletin*

Majors Offered
Computer Science
Computer Science with Specialization in Mathematics
Computer Science with Specialization in Business

Minor Offered
Computer Science

Departmental Requirements

A grade of C (2.00) is required in all CSSE courses that are prerequisites to other required CSSE courses. Only courses graded C (2.00) or higher may be transferred to satisfy degree requirements. Transfer credits in the major require departmental approval. The MATH 134, 135, 136 sequence can be fulfilled by any three quarter or two semester calculus sequence from which Seattle University accepts the first course or courses as substitutes for MATH 134 and 135. Both the cumulative grade point average and grade point average for major/department courses completed at Seattle University must be at least 2.50 for graduation.

Bachelor of Arts
Major in Computer Science

The bachelor of arts degree with a major in computer science requires students to complete a minimum of 180 quarter credits with both a cumulative grade point average and a major/department grade point average of 2.50 or better.

I. Core Curriculum Requirements

ENGL 110   **College Writing: Inquiry and Argument** 5
PHIL 110   **Introduction to Philosophy and Critical Thinking.** 5

Choose one of the following two courses: 5
HIST 120   **Origins of Western Civilization**
HIST 121   **Studies in Modern Civilization**

ENGL 120   **Masterpieces of Literature** 5
Lab Science   5
Fine Arts (one approved 5 credit course, see course descriptions)............................ 5
PHIL 220 Philosophy of the Human Person 5
Social Science I   5
Social Science II (different discipline from Social Science I).. 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied by CSSE 481
Senior Synthesis filled by CSSE 486, 488, and 489.

II. Major Requirements

59 credits in computer science, including:
CSSE 151   **Fundamentals of Computer Science I**.. 5
CSSE 152   **Fundamentals of Computer Science II**... 5
CSSE 250   **Data Structures** 5
CSSE 308   **Technical Communications**... 3
CSSE 370   **Fundamentals of Databases I** 5
CSSE 380   **Organization of Programming Languages** 5
CSSE 481   **The Art of Web Design** 5
CSSE XXX   **CSSE Electives**.. 15
(10 Credits must be 300 level or above, excluding CSSE 482-483, 486-489)
CSSE 486   **Software Engineering Project**... 5
CSSE 488   **Software Engineering & Project Development II** 3
CSSE 489   **Software Engineering & Project Development III**.................................... 3

III. Other Major Department Requirements

45 credits including:

MATH 134	**Calculus I**...	**5**
MATH 135	**Calculus II**..	**5**

Choose one of the following two courses:...5

MATH 244	**Probability and Statistics**
MATH 351	**Probability**

*Area of Application **30**

*Bachelor of arts degree students must complete a coordinated group of application area courses. These courses must include at least 30 credits of courses in an area of proposed application of computer science. These 30 credits may be those prescribed for a minor in another department, but may not include any credits already required by the Computer Science Department for the bachelor of arts degree. In areas of application where a minor is not prescribed, the Computer Science Department will define the acceptable application area courses, with the assistance of the appropriate departments.

Bachelor of Science in Computer Science
Major in Computer Science—General Option

The bachelor of science in computer science degree (BSCS) requires students to complete at least 180 quarter credits with both a cumulative grade point average and a major/department grade point average of 2.50 or better.

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**	**5**
Fine Arts (one approved 5 credit course, see course descriptions)		**5**
PHIL 220	**Philosophy of the Human Person**	**5**
Social Science I	....	**5**
Social Science II (different discipline from Social Science I)		**5**
Theology and Religious Studies Phase II (200-299)		**5**
Ethics (upper division)		**5**
Theology and Religious Studies Phase III (300-399)		**5**
Interdisciplinary	....	**3**

Senior Synthesis filled by CSSE 487, 488, 489

II. Major Requirements

84 credits in computer science, including:

CSSE 151	**Fundamentals of Computer Science I**	**5**
CSSE 152	**Fundamentals of Computer Science II**	**5**
CSSE 210	**Foundations of Computer Science**	**5**
CSSE 250	**Data Structures**	**5**
CSSE 251	**Introduction to Computer Organization**	**5**
CSSE 308	**Technical Communications**	**3**

CSSE 310	**Design and Analysis of Algorithms** 5
CSSE 320	**Object-Oriented Development**... 5
CSSE 340	**Operating Systems** 5
CSSE 350	**Theoretical Computer Science** 5
CSSE 370	**Fundamentals of Databases I** 5
CSSE 380	**Organization of Programming Languages** 5
CSSE 487	**Software Engineering & Project Development I** 5
CSSE 488	**Software Engineering & Project Development II** 3
CSSE 489	**Software Engineering & Project Development III** 3
CSSE 4XX	**Electives (400-level, excluding 480-483, 486-489)** 15

III. Other Major Department Requirements

38 credits in mathematics, physics, and science including:

MATH 134	**Calculus I** 5
MATH 135	**Calculus II** 5
MATH 136	**Calculus III** 5
MATH 233	**Linear Algebra** 3
PHYS 121	**Mechanics** 5

Choose two of the following six options: 10

PHYS 122	**Electricity and Magnetism**
PHYS 123	**Waves and Optics**
BIOL 161 & 171	**Biology I: Molecular and Cellular Biology and Lab**
BIOL 240	**Genetics**
CHEM 121 & 131	**General Chemistry I and Lab**
CHEM 122 & 132	**General Chemistry II and Lab**

Choose one of the following two courses: 5

MATH 244	**Fundamentals of Probability and Statistics**
MATH 351	**Probability**

Bachelor of Science in Computer Science
Major in Computer Science with a
Specialization in Business

The specialization in business will prepare students for information management or information technology positions, which are increasingly critical in most companies. In addition to computer science requirements (69 credits), the student will take at least 30 credits of business courses through the Albers School of Business and Economics.

This bachelor of science in computer science degree requires students to complete at least 180 quarter credits with both a cumulative grade point average and a major/specialization/department grade point average of 2.50 or better.

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument** 5
PHIL 110	**Introduction to Philosophy and Critical Thinking** 5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Masterpieces of Literature** 5

Lab Science 5

Fine Arts (one approved 5 credit course; see course descriptions).............................. 5

PHIL 220   **Philosophy of the Human Person** 5

Social Science I (not economics) 5

Social Science II filled by ECON 271.. 5

Theology and Religious Studies Phase II (200-299) 5

Ethics (upper division).. 5

Theology and Religious Studies Phase III (300-399) 5

Interdisciplinary satisfied by CSSE 481

Senior Synthesis filled by CSSE 487, 488, 489

II. Major Requirements

69 credits in computer science, including:

CSSE 151	**Fundamentals of Computer Science I**	5
CSSE 152	**Fundamentals of Computer Science II**	5
CSSE 210	**Foundations of Computer Science**	5
CSSE 250	**Data Structures**	5
CSSE 308	**Technical Communications**	3
CSSE 310	**Design and Analysis of Algorithms**	5
CSSE 320	**Object-Oriented Development**	5
CSSE 370	**Fundamentals of Databases I**	5
CSSE 380	**Organization of Programming Languages**	5
CSSE 481	**The Art of Web Design**	5
CSSE 487	**Software Engineering & Project Development I**	5
CSSE 488	**Software Engineering & Project Development II**	3
CSSE 489	**Software Engineering & Project Development III**	3
CSSE 4XX	**Electives (400-level, excluding 480-483, 486-489)**	10

III. Business Specialization Requirements

30 credit hours in ASBE satisfying one of the following:... 30

Courses required for minor in Accounting or

Courses required for minor in Business Administration or

Courses required for minor in Economics or

Courses required for minor in Entrepreneurship and Innovation or

Courses required for minor in Finance or

Courses required for minor in International Business or

30 Approved credit hours of upper-level ASBE courses

IV. Other Major Department Requirements

15 credits including:

MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5

Choose one of the following two courses:.. 5

ECON 260	**Business Statistics**
ECON 310	**Quantitative Methods and Applications**

NOTE: 1. Each student must complete a business specialization in accounting, business administration, economics finance, entrepreneurship and innovation or international business, by completing the courses specified by the ASBE for these minors in the chosen area of specialization. Students should be aware that the ASBE does not allow students completing this program to also minor in business administration.

2. BSCS business specialization students must meet all prerequisites for courses taken and must be at least at junior standing when enrolled in 300/400 level courses from Albers School of Business and Economics. 3. Business courses are subject to the same grade minimums as for business administration majors. 4. The total number of business credits, prerequisite plus required credit hours in business cannot exceed 24 percent of a student's total credit hours (ECON 260, ECON 271, ECON 310 do not count as business hours).

Bachelor of Science in Computer Science
Major in Computer Science with a
Specialization in Mathematics

This specialization requires students to take 64 credits in computer science and 50 credits in mathematics. The combination of mature skills in applied mathematics and strong computer applications skills is a rare and valuable combination.

This bachelor of science in computer science degree requires students to complete at least 180 quarter credits with both a cumulative grade point average and a major/specialization grade point average of 2.50 or better.

I. Core Curriculum Requirements

ENGL 110   **College Writing: Inquiry and Argument** 5
PHIL 110   **Introduction to Philosophy and Critical Thinking** 5
Choose one of the following two courses: 5
HIST 120   **Origins of Western Civilization**
HIST 121   **Studies in Modern Civilization**

ENGL 120   **Masterpieces of Literature** 5
Fine Arts (one approved 5 credit course; see course descriptions).. .5
PHIL 220   **Philosophy of the Human Person**... 5
PHYS 121   **Mechanics** 5
Social Science I   5
Social Science II (different discipline from Social Science I)... 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper-division)... 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   3
Senior Synthesis filled by CSSE 487, 488, 489

II. Major Requirements

64 credits in computer science courses, including:
CSSE 151   **Fundamentals of Computer Science I**.. 5
CSSE 152   **Fundamentals of Computer Science II**... 5
CSSE 250   **Data Structures**... 5
CSSE 251   **Introduction to Computer Organization** 5
CSSE 308   **Technical Communications**... 3
CSSE 310   **Design and Analysis of Algorithms** 5
CSSE 320   **Object-Oriented Development**... 5
CSSE 340   **Operating Systems**.. 5
CSSE 350   **Theoretical Computer Science** 5
CSSE 370   **Fundamentals of Databases I** 5
CSSE 380   **Organization of Programming Languages** 5

CSSE 487	**Software Engineering & Project Development I** 5
CSSE 488	**Software Engineering & Project Development II**.................................... 3
CSSE 489	**Software Engineering & Project Development III** 3

III. Mathematics Specialization Requirements

50 credits in mathematics courses, including:

MATH 134	**Calculus I**.. 5
MATH 135	**Calculus II**... 5
MATH 136	**Calculus III** 5
MATH 232	**Multivariable Calculus** 3
MATH 233	**Linear Algebra**.. 3
MATH 234	**Differential Equations**... 4

Choose one of the following two courses: 5

| CSSE 210 | **Foundations of Computer Science** |
| MATH 310 | **Introduction to Advanced Mathematics** |

Choose one of the following two courses: 5

| MATH 244 | **Probability and Statistics** |
| MATH 351 | **Probability** |

Choose three of the following four courses:... 15

MATH 331	**Introduction to Complex Variables**
MATH 361	**Applied Mathematics I**
MATH 371	**Introduction to Numerical Methods**
MATH 461	**Applied Mathematics II**

Minor in Computer Science

In order to earn a minor in computer science, students must complete 30 quarter credits in computer science, selected from:

CSSE 151	**Fundamentals of Computer Science I** 5
CSSE 152	**Fundamentals of Computer Science II** 5
CSSE 250	**Data Structures**.. 5

Choose 5 credits from:

| CSSE 320 | **Object-Oriented Development**... 5 |
| CSSE 380 | **Organization of Programming Languages** .... 5 |

Choose an additional 10 credits from:

CSSE 310	**Design and Analysis of Algorithms** 5
CSSE 320	**Object-Oriented Development**... 5
CSSE 340	**Operating Systems**.. 5
CSSE 350	**Theoretical Computer Science** 5
CSSE 370	**Fundamentals of Databases I** 5
CSSE 380	**Organization of Programming Languages** 5
CSSE 422	**Design Patterns**.. 5
CSSE 434	**Software Testing and Debugging** 5
CSSE 444	**Concurrent and Distributed Systems** 5
CSSE 460	**Computer Networks**.. 5
CSSE 465	**Computer Graphics** 5

CSSE 470	**Artificial Intelligence** 5
CSSE 471	**Fundamentals of Databases II** 5
CSSE 481	**The Art of Web Design** 5
CSSE 485	**Compiler Principles and Techniques** 5

See policy for minors (84-1) for more information.

Computer Science Courses

CSSE 103   Introduction to Computers and Applications 5

An introduction to computer applications and concepts. Applications include word processing, spreadsheets, databases, electronic mail, and other Internet tools. Also covers historical development of computers. A brief introduction to hardware and software, and other concepts of modern computing. Computer-related social and ethical issues. No prior experience with computers required. (fall, winter, spring)

CSSE 108   Database Applications 5

An introduction to databases for the non-computer science major. Includes relational database modeling (using a DBMS such as Microsoft Access), designing the database, creating the tables, reports, forms and queries. Other topics may include transferring data between spreadsheets and database, automating applications, linking to other databases and database security.

CSSE 151   Fundamentals of Computer Science I 5

Introduction to the fundamentals of computer science, including programming in a modern high-level language with emphasis on programming design and style. Algorithm development, stepwise refinement, control structures, functions, elementary search algorithms, primitive and aggregate data types. Prerequisite: C- or better in MATH 120 or equivalent.

CSSE 152   Fundamentals of Computer Science II 5

Continuation of the introduction to the fundamentals of computer science, including abstract data types (ADTs), recursion, linked lists, stacks, queues, binary trees and function overloading. Prerequisite: C (2.00) or better in CSSE 151.

CSSE 191-193   Special Topics .... 1 to 5

CSSE 205   Programming for Web & Business Applications 5

An introduction to graphical user interface programming and applications using a simplified programming language (such as Visual Basic). Topics include simple event-driven programming and interface design. Other topics may include web form, working with graphics and an introduction to object-oriented programming.

CSSE 210   Foundations of Computer Science 5

Introduction to logic, digital logic design and other applications of logic to computer science, functions, combinatorics, equivalence relations, methods of proof, induction, recurrence relations and recursion in programming languages, graphs, graph implementations and applications. Prerequisites: MATH 135 and C (2.00) or better in CSSE 152.

CSSE 230   FORTRAN for Science and Engineering 3

Introduction to FORTRAN programming for science and engineering computing. Emphasis on algorithm development and stepwise refinement for solving science and engineering problems. Introduction to numerical techniques. Laboratory programming assignments will be taken primarily from the fields of engineering and science. Credit not granted for both CSSE 230 and CSSE 231. Prerequisites: MEGR 230; plus MATH 232 and 233.

CSSE 231   C Programming for Science and Engineering **3**
Introduction to C programming, in a UNIX environment, for science and engineering computing. Emphasis on algorithm development, stepwise refinement for solving science and engineering problems. Programming assignments will be drawn from the fields of engineering and science. Credit not granted for both CSSE 230 and CSSE 231. Prerequisites: MEGR 230; plus MATH 232 and 233.

CSSE 250   Data Structures **5**
Abstract data types. Big-Oh notation. Heaps, sorting (Quicksort, Mergesort, Heapsort), binary search trees, tree balancing techniques, and hashing. Additional topics may include B trees. Prerequisite: C (2.00) or better in CSSE 152.

CSSE 251   Introduction to Computer Organization **5**
Basic concepts of digital logic design, computer hardware (CPU components, memory hierarchies, I/O, interrupts), data representation (integer and floating point, characters, arrays, and structured data), Instruction Set Architectures (design trade-offs, RISC vs CISC, assembly language and machine language, realizations of high-level language constructs). Implementation via programming in an assembly language. Prerequisite: C (2.00) or better in CSSE 152.

CSSE 291-293   Special Topics.. **1 to 5**
CSSE 296   Directed Study .... **1 to 5**
CSSE 308   Technical Communications.. **3**
Communication skills for computer professionals. Writing, speaking, electronic communication. Structure and content of software documentation. CS Majors are to take this course concurrently with CSSE 487 or 486, the first quarter of the capstone software project course. Prerequisite: ENGL 110 and a C (2.00) or better in CSSE 250.

CSSE 310   Design and Analysis of Algorithms **5**
Advanced data structures (e.g. sets, graphs, priority queues) and their application; algorithm analysis and design techniques, such as divide and conquer, greedy methods, branch and bound, etc. Asymptotic analysis of algorithms and introduction to computability theory. Prerequisites: C (2.00) or better in CSSE 250 and either MATH 310 or a C (2.00) or better in CSSE 210.

CSSE 320   Object-Oriented Development... **5**
Fundamentals and principles of object-oriented development, including classes, containment, inheritance, overloading and polymorphism. Object-oriented analysis, design and programming. Prerequisite: C (2.00) or better in CSSE 250.

CSSE 340   Operating Systems.. **5**
Computer system overview (devices, interrupts, memory hierarchy), and the basic concepts of operating systems from an applications programming perspective. Topics include processes, process scheduling, threads, deadlock, synchronization, memory management, I/O, and networking. Pre-requisites: C (2.00) or better in CSSE 250 and a C (2.00) or better in either CSSE 251 or ECEGR 304.

CSSE 350   Theoretical Computer Science **5**
An introduction to the formal mathematical basis of computer science and functional language programming. Topics include regular sets (finite automata, regular expressions, regular grammars, applications), context-free languages (grammars, pushdown automata, normal forms, applications), Turing machines, and functional programming. Prerequisites: C (2.00) or better in CSSE 250 and either MATH 310 or a C (2.00) or better in CSSE 210.

CSSE 370   Fundamentals of Databases I **5**
Introduction to database management systems, architecture, architecture, and environment. Relational database design including data modeling and schema design. Coverage of SQL query language for application development. Overview fundamental concepts of transaction management, security and recovery control. Prerequisite: C (2.00) or better in CSSE 250.

CSSE 380   Organization of Programming Languages **5**
Overview of common features, organization and tradeoffs of modern programming languages, with an emphasis on scripting languages. Semantics, garbage collection and memory management issues, and type systems. Prerequisite: C (2.00) or better in CSSE 250.

CSSE 391-393   Special Topics .... **1 to 5**

CSSE 396   Directed Study .... **1 to 5**

CSSE 422   Design Patterns **5**
Categorization of standard design patterns, their use, expected benefit(s) and associated cost(s). Explication and analysis of creational, interface, structural and behavioral patterns. Prerequisite: C (2.00) or better in CSSE 320.

CSSE 434   Software Testing and Debugging **5**
Overview of testing and debugging principles. Topics include program analysis, testing adequacy, functional testing, structural testing, unit testing, integration testing, and systematic debugging. Prerequisites: C (2.00) or better in one 300-level CSSE course and either MATH 222, 310, or a C (2.00) or better in CSSE 210.

CSSE 444   Concurrent and Distributed Systems **5**
Parallel computation using multiple interacting systems. Distributed system architectures, cluster computing including Beowulf clusters, peer-to-peer architectures. Adapting algorithms for parallel computation. Fault tolerance, scalability, resource sharing. Prerequisites: C (2.00) or better in CSSE 340 and a C (2.00) or better in CSSE 310.

CSSE 460   Computer Networks **5**
The principles of networking with emphasis on the TCP/IP protocol suite upon which the Internet is based. Client-server network programming. Topics include layering of network protocols, application protocols such as HTTP, reliable data transfer, routing, and link layer protocols such as Ethernet. Prerequisite: C (2.00) or better in CSSE 340.

CSSE 465   Computer Graphics **5**
Fundamentals of computer graphics. Techniques of computer image synthesis. Line-drawing and color raster graphics. Homogeneous coordinates, hidden line and surface, and smooth shading algorithms. Prerequisite: C (2.00) or better in CSSE 250 and either MATH 310 or a C (2.0) or better in CSSE 210.

CSSE 470   Artificial Intelligence **5**
Principal ideas and developments in artificial intelligence, including knowledge representation, goal-directed problem solving, optimal and sub-optimal search, theorem proving, pattern matching. Additional topics may include expert systems, neural nets, simulated annealing, genetic algorithms. Prerequisite: C (2.00) or better in CSSE 310 and CSSE 380.

CSSE 471   Fundamentals of Databases II **5**

A continuation of the CSSE 370 Fundamentals of Databases I course. Topics include advanced data models including the enhanced entity relationship model, object-oriented and object-relational data models, physical data storage in database systems, transaction processing, concurrency control, recovery techniques, query processing and optimization, database security and authorization, and more advanced application programming for database systems covered in the 370 course. Prerequisite: C (2.00) or better in CSSE 370.

CSSE 480   Interdisciplinary Core Course .... **3 to 5**

Title and content vary.

CSSE 481   The Art of Web Design **5**

An introduction to website design with emphasis on the area of human computer interaction (HCI). Topics include defining the audience, planning the site, prototyping and testing the design. HCI topics include an introduction to cognitive psychology, user-centered design methodology and memory characteristics as pertains to interface design. Technical aspects of creating a site include basic text markup, scripting languages and other web tools. Core interdisciplinary option. Cannot be used as a CSSE 400-level elective. Prerequisite: PHIL 110.

CSSE 482   Computer Games: Design and Effect **3**

Examine and create computer games with an emphasis on the perspectives of storytelling and strategic thinking. Evaluate game genres, play and icons with respect to cultural impact and relevance to audience considerations such as age, race, gender and other factors. Fundamental problem-solving techniques explored for implementation via an easy-to-use programming design tool. Cannot be used as a CSSE 400-level elective. Core interdisciplinary option. Pre/Co-requisite: ENGL 120.

CSSE 483   CyberSecurity **3**

Overview of computer security issues at both the personal computer, local area network and Internet computing levels. Of interest to students in business, communication, criminal justice, economics, political science, psychology, science and sociology. Topics include attacks and threats on computer systems such as unwanted email, viruses, hackers, spyware and denial of services; identity and monetary theft by discovering banking and credit card information via banks, retail outlets, Internet web sites and other business entities; and countermeasures that one should take such as adding computer firewalls, installing and updating security software, and a plan for backup and disaster recovery. Examples of actual cases are presented and analyzed along with suggestions for improving security on them. Cannot be used as a CSSE 400-level elective. Core interdisciplinary option.

CSSE 485   Compiler Principles and Techniques **5**

Lexical analyzers, top and bottom-up parsing and LL(k), LR, etc. grammars, symbol tables, internal forms and intermediate languages, code generation, code optimization, semantic specifications, error detection and recovery, comparison methods. Use of software tools for lexical analysis and parsing. Prerequisites: C (2.00) or better in CSSE 251, CSSE 350 and CSSE 380.

CSSE 486   Software Engineering Project **5**

Meets regularly in the fall quarter, to cover the principles of software engineering, and to initiate software project activities. Prerequisite: C (2.00) or better in CSSE 370, CSSE 380, CSSE 481 and a major GPA of 2.50 or higher. Co-requisite: CSSE 308.

CSSE 487   Software Engineering and Project Development I **5**

Meets regularly in the fall quarter, to cover the principles of software engineering, and to initiate software project activities. Prerequisite: C (2.00) or better in CSSE 310, CSSE 320, CSSE 370, and CSSE 380 and a major GPA of 2.50 or higher. Co-requisite: CSSE 308.

CSSE 488   **Software Engineering and Project Development II** **3**

Meets as required to continue software project work initiated in the fall quarter. Prerequisite: C (2.00) or better in CSSE 487 or C (2.00) or better in CSSE 486. (winter)

CSSE 489   **Software Engineering and Project Development III** **3**

Meets as required to complete software projects by end of spring quarter. Prerequisite: C (2.00) or better in CSSE 488. (spring)

Principles of software engineering and their application in the planning and execution of a three-quarter-long software development project. Students work in teams to define and carry out software projects from initial requirements statements to final implementation. Activities include project planning and management, as well as analysis, design and implementation of the software project. In CSSE 486 and CSSE 487, projects are defined and requirement specifications developed by the project teams. The required software products are then designed and implemented in CSSE 488 and 489, culminating in a formal presentation of results at the end of the spring quarter. The three courses, CSSE 487 (or CSSE 486 for students pursuing a B.A. degree), 488, and 489, must be taken as a continuous sequence and together, they fulfill the senior synthesis core requirement.

CSSE 491-493   **Special Topics** .... **1 to 5**
CSSE 496   **Independent Study** .... **1 to 5**
CSSE 497   **Directed Reading** .... **1 to 5**
CSSE 498   **Directed Research** .... **1 to 5**

Diagnostic Ultrasound

Carolyn Coffin, MPH, RDMS, RVT, RDCS, Chair

Objectives

The diagnostic ultrasound program prepares students for the profession of diagnostic medical sonography. Founded on a concentration in basic sciences, the program affords simultaneous opportunities for receiving a liberal arts education, as well as didactic and practical exposure to a range of ultrasound specialties. This approach leads not only to competence in the practice of sonography, but also to the development of future leaders in the field.

Degree Offered
Bachelor of Science in Diagnostic Ultrasound

Major Offered
Diagnostic Ultrasound

Accreditation

The diagnostic ultrasound program is accredited by the Commission on Accreditation of Allied Health Education Programs, (CAAHEP).

Program Admission

Individuals may apply for the major of diagnostic ultrasound as freshmen or transfer students from other colleges. Transfer applicants and change of major students will be considered according to admission requirements of the College of Science and Engineering and the department of diagnostic ultrasound. Some supplementary materials are required with transfer student applications. Applicants are encouraged to participate in volunteer or paid health care related activities that promote the development of communication and interpersonal skills and provide an opportunity to evaluate their own suitability to work with patients and the public. All majors are required to meet with program faculty prior to progressing to the third year.

Departmental Requirements (Policy 81-3)

Students must earn a grade of C or higher and an average GPA of 2.50 or higher in PHYS 105, 106, MATH 131, BIOL 161/171, 200, 210 and a biology elective. Any biology, diagnostic ultrasound didactic, diagnostic ultrasound internship, ultrasound physics or pathophysiology course in which a grade lower than a C is earned must be repeated. No further ultrasound course may be taken until the student has earned an acceptable grade. Any course may be repeated only once.

The major requirements, as well as pathophysiology, are taken the third and fourth year of the program. Prior to the third year of the program all students will have completed the math and science prerequisites and all but fifteen (15) credits of the core requirements. Advancement to the third year courses also involves review and approval by the department chair and advisors. The final year of the program is 12 months of internship in a health care facility, which is arranged by a clinical coordinator.

Bachelor of Science in Diagnostic Ultrasound

In order to earn the degree of bachelor of science in diagnostic ultrasound degree, students must complete a minimum of 181 quarter credits with a cumulative and major/program grade point average of 2.80, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	5
PHIL 220	**Philosophy of the Human Person**	5
Social Science I		5

Social Science II (different discipline from Social Science I) 5

Theology and Religious Studies Phase II (200-299) 5

Ethics (upper-division; prefer Health Care Ethics) 5

Theology and Religious Studies Phase III (300-399) 5

Interdisciplinary satisfied by DIUS 370

Senior Synthesis satisfied by Ultrasound Internship (DIUS 473,474, 487,488)

II. Major Requirements

91 credits in diagnostic ultrasound, including:

DIUS 304	**Pathophysiology - Medical Imaging**	4
DIUS 330	**Diagnostic Ultrasound I**	4
DIUS 331	**Diagnostic Ultrasound II**	4
DIUS 332	**Echocardiography**	4
DIUS 333	**Methods of Cardiac Evaluation**	2
DIUS 334	**Vascular Evaluation and Doppler**	4
DIUS 340	**Diagnostic Ultrasound Lab I**	1
DIUS 341	**Diagnostic Ultrasound Lab II**	1
DIUS 342	**Diagnostic Ultrasound Lab III**	1
DIUS 344	**Vascular Evaluation and Doppler Lab**	1
DIUS 350	**Ultrasound Physics**	3
DIUS 351	**Instrumentation Lab**	1
DIUS 355	**Human Cross Section Anatomy**	5
DIUS 370	**Research and Professional Issues**	4
DIUS 375	**Ultrasound Instrumentation**	4
DIUS 380	**Advanced Ultrasound Topics**	2

Senior Synthesis: Ultrasound Internship*

DIUS 471	**Clinical Experience in Ultrasound I**	*10
DIUS 472	**Clinical Experience in Ultrasound II**	*8
DIUS 473	**Clinical Experience in Ultrasound III**	*8
DIUS 474	**Clinical Experience in Ultrasound IV**	*8
DIUS 487	**Ultrasound Seminar I***	
	(must be taken four times, 2 credits each)	*8

DIUS 488   **Basic Science of Ultrasound***
                           (must be taken twice, 2 credits each)... ***4**

*A calendar-year internship is necessary for entry into professional employment and certification. This internship is a part of the degree and follows after the academic course requirements are met. Because of the professional nature of the program, qualities in addition to a good grade point average are required of internship candidates.

NOTE: 1. Students must provide physician verification of good health and immunizations prior to ultrasound-specific courses. 2. All courses must be graded C (2.00) or higher.

III. Other Major Department Requirements

BIOL 161/171   **Biology I: Molecular and Cellular Biology and Lab**
                         (majors level biology, not 100/101) ***5**
BIOL 200   **Anatomy and Physiology I** ***5**
BIOL 210   **Anatomy and Physiology II** ***5**
BIOL   **Elective (majors level biology, not 100/101)** ***5**
Elective as determined by Diagnostic Ultrasound **5**
PHYS 105   **Mechanics** ***5**
PHYS 106   **Waves, Sound, Electricity and Magnetism** ***5**

Choose option a, b, or c ....***5 or 10**
a. MATH 131   **Calculus for Life Sciences (preferred) (5)**
b. MATH 130   **Elements of Calculus for Business (5)**
c. MATH 134   **Calculus I (5)**
   MATH 135   **Calculus II (5)**

NOTE: 1. MATH 120 and MATH 121 are prerequisites to PHYS 105 and MATH 131. Contact the department regarding preferred course sequence. 2. A grade of C or higher is required.

Diagnostic Ultrasound Courses

DIUS 304   **Pathophysiology—Medical Imaging**.. **4**
An conceptual approach to alterations in the structure and function that occur in human organ systems as a result of disease processes. The cellular, biological and/or genetic basis for these pathologies will be discussed. Prerequisites: BIOL 200 and 210. (fall)

DIUS 330   **Diagnostic Ultrasound I** **4**
Pathophysiology of obstetrics and pelvic organ systems evaluated by ultrasound and their sonographic appearance. Integration of ultrasound physics, instrumentation, and principles. Prerequisites: DIUS 304, 331, 333, 334, 341, 344 ,350, 375. Co-requisite: DIUS 340. (spring)

DIUS 331   **Diagnostic Ultrasound II** **4**
Pathophysiology of abdominal organ systems evaluated by ultrasound and their sonographic and Doppler appearance. Introduction to hemodynamics of abdominal and vascular systems. Integration of ultrasound physics, instrumentation, and principles. Prerequisites: DIUS 304, 355, 350, 370, 375. Co-requisite: DIUS 341. (winter)

DIUS 332   **Echocardiography** **4**
Anatomy, physiology, and pathology of the adult and pediatric heart. Integration of ultrasound physics, instrumentation, and principles. Prerequisites: DIUS 304, 331, 333, 334, 341, 344, 350, 370, 375. Co-requisite: DIUS 342. (spring)

DIUS 333　　　　**Methods of Cardiac Evaluation** 2

Integration of various modes of cardiac evaluation with echocardiography. Cardiac catheterization, ECG, auscultation, and cardiac pharmacology are covered in addition to other pertinent topics. The course serves to expand students' knowledge of cardiac physiology and pathophysiology. Open to all qualified majors, and non-majors by instructor permission. Prerequisite: DIUS 350.

DIUS 334　　　　**Vascular Evaluation and Doppler**.. 4

Introduction to hemodynamics and the application of Doppler ultrasound for the detection and evaluation of vascular anatomy, physiology, and pathology. Additional methods of evaluating vascular disease which complement Doppler data. Integration of ultrasound physics, instrumentation, and principles. Prerequisites: DIUS 304, 350, 355, 370. Co-requisite: DIUS 344. (winter)

DIUS 340　　　　**Diagnostic Ultrasound Lab I** 1

Hands-on experience in scanning pelvic structures. Simulator experience scanning obstetrical model. Practice in modes of equipment operation and safety. Co-requisite: DIUS 330. (spring)

DIUS 341　　　　**Diagnostic Ultrasound Lab II** 1

Hands-on experience in scanning abdominal organ systems. Practice in modes of equipment operation and safety. Co-requisite: DIUS 331. (winter)

DIUS 342　　　　**Echocardiography Lab** 1

Hands-on experience in the evaluation of sonographic appearances of the heart with real-time 2-D imaging, Doppler, and M-mode echocardiography. Practice in modes of equipment operation and safety. Co-requisite: DIUS 332.

DIUS 344　　　　**Vascular Evaluation and Doppler Lab**.. 1

Hands-on experience in scanning the peripheral vascular system and extracerebral circulation. Hands-on experience with physiologic testing equipment. Practice in modes of equipment operation and safety. Co-requisite: DIUS 334.

DIUS 350　　　　**Ultrasound Physics**... 3

An introduction to ultrasound physics. Topics include the physics of pulsed ultrasound, including its production and detection by transducers; characteristics of pulses and sound beams; interaction of ultrasound with tissue, including attenuation, impedance, reflection, refraction, scattering and ranging; hemodynamics; the Doppler effect; introduction to ultrasonic instrumentation. Prerequisites: PHYS 106 or equivalent; MATH 131 or 134; enrollment in the diagnostic ultrasound program or permission of the diagnostic ultrasound department.

DIUS 351　　　　**Instrumentation Lab** 1

A review of the ultrasound systems and the controls used to change imaging parameters. Students will learn how each control affects the ultrasound image and the reasons for making changes to the image; and will participate in simple scanning experiments to demonstrate image manipulation and the properties of high-frequency sound. Co-requisite: DIUS 350. (fall)

DIUS 355　　　　**Human Cross Section Anatomy**.. 5

Survey of cross section anatomy with emphasis on organs of body amenable to ultrasound diagnostic techniques. Prerequisites: BIOL 210; PHYS 106.

DIUS 370　　　　**Research and Professional Issues**... 4

Introduction to basic scientific writing, study design and critique, statistical analysis, and formulation and testing of hypotheses. Examination of ethical, legal, and psycho-social aspects of health care. Methods of budgeting, hiring, firing, and departmental administration. The sonographer's role in relation to the patient, physician, and staff. Fulfills interdisciplinary core requirement. Open to all qualified majors, and non-majors by instructor permission.

DIUS 375   **Ultrasound Instrumentation** **4**

Understanding the operation of diagnostic ultrasound equipment, including B-mode, M mode, 2-D/real-time and Doppler systems, quality assurance, and safety. Prerequisite: DIUS 350.

DIUS 380   **Advanced Ultrasound Topics** **2**

This course will include extensive review of ultrasound images and patient exams in a variety of ultrasound specialty areas. Students will organize and present cases and discuss ultrasound findings, correlate lab results with patient exams and determine a differential diagnosis. This course will also include advanced lectures in ultrasound imaging and technologies. Prerequisites: DIUS 304, 331, 333, 334, 350, 355, 370, 375. Co-requisites: 330, 332.

DIUS 391-393   **Special Topics** .... **1 to 5**

DIUS 396   **Directed Study** .... **1 to 5**

DIUS 471   **Clinical Experience In Ultrasound I** **10**

40 hours a week spent in an approved ultrasound clinical practice learning patient care, practical medical ethics, observing and performing ultrasound procedures and other diagnostic modalities. Prerequisite: Successful completion of all DIUS didactic courses and compliance with policy (81-3). Co-requisite: DIUS 487.

DIUS 472   **Clinical Experience in Ultrasound II** **8**

40 hours a week in an approved ultrasound clinical practice. Prerequisite: DIUS 471 and compliance with policy (81-3). Co-requisite: DIUS 487.

DIUS 473   **Clinical Experience in Ultrasound III** **8**

40 hours a week in an approved ultrasound clinical practice. Prerequisites: DIUS 471, 472 and compliance with policy (81-3). Co-requisite: DIUS 487.

DIUS 474   **Clinical Experience in Ultrasound IV** **8**

40 hours a week in an approved ultrasound clinical practice. Prerequisites: DIUS 471, 472, 473 and compliance with policy (81-3). Co-requisite: DIUS 487.

DIUS 487   **Ultrasound Seminar I** **2**

Seminar to review and discuss cases performed by students and issues of professional interest. Seattle-based students meet on campus one day every week. Students based outside Seattle area present projects by distance learning. Program requires this course be taken four times for a maximum of eight credits. Fulfills senior synthesis core requirement, together with DIUS 488. Co-requisite: 471, 472, 473 or 474. Prerequisite: Clinical internship assignment. Mandatory CR/F grading.

DIUS 488   **Basic Science of Ultrasound** **2**

Project of professional interest assigned by faculty involving critical examination of current literature and research techniques. Program requires this course be taken twice for a maximum four credits. Fulfills senior synthesis requirement together with DIUS 487. Co-requisites: DIUS 472, 473. Prerequisite: successful completion of all DIUS didactic courses and compliance with policy (81-3).

DIUS 491-493   **Special Topics** .... **1 to 5**

DIUS 496   **Independent Study** .... **1 to 5**

Electrical and Computer Engineering

Paul Neudorfer, PhD, Chair

Objectives

Electrical engineering is concerned with the use of electrical energy for the benefit of society. The profession of electrical engineering is scientifically based and design oriented. As such, its practice draws heavily upon the areas of mathematics, physics, and computer science as well as other branches of engineering and natural science.

The program strives to provide a broad foundation that will prepare graduates for productive lifelong careers in any of the various sub-fields of electrical engineering. The Department of Electrical and Computer Engineering is teaching oriented and offers an undergraduate program that provides an integrated, contemporary perspective of the electrical engineering profession. The department's goals are contained within its mission statement and related objectives:

Mission Statement

Within the rich tradition of Jesuit education, it is the mission of the Department of Electrical and Computer Engineering to teach and prepare broadly-educated, socially-responsible, articulate, and skilled engineers for leadership in electrical engineering and related fields.

Program Objectives

The department strives to prepare graduates who have the following traits:

- **Technical Proficiency:** Basic knowledge in mathematics, physics, computing, and engineering theory and practice appropriate to the students' chosen areas of specialization.
- **Communication Skills:** Ability to communicate effectively and to critically evaluate meaning in written, oral, and graphical forms.
- **Professional Development:** Appreciation of the broad spectrum of abilities needed in professional practice including skills in teamwork, leadership, creativity, and project management, and an understanding of professional ethics, workplace conventions, safety, and economics.
- **Personal Breadth:** Appreciation of non-technical aspects of engineering, including ethical considerations, concern for society and the environment, and multi-cultural perspectives, as well as a commitment to life-long learning and service to the professional and civic communities.

Degree Offered
Bachelor of Science in Electrical Engineering

Majors Offered
Electrical Engineering
Electrical Engineering with a specialization in Computer Engineering

Minor Offered
Electrical Engineering

Departmental Requirements

In addition to individual course prerequisites, departmental candidacy in one of the engineering departments is required for entry into 300 and 400 level courses. Candidacy is achieved by successfully completing all required 100 and 200 level CSSE, ECEGR, MATH, and PHYS courses and ENGL 110 with a combined grade point average of 2.50 or higher. Only courses graded C (2.00) or higher may be transferred from other institutions. Once enrolled in the department, 300- and 400-level courses may be transferred only with permission.

The BSEE degree is accredited by the Engineering Accreditation Commission of ABET, formerly known as the Accreditation Board for Engineering and Technology.

Electrical Engineering Curricular Blocks

Courses taken to fulfill requirements toward the bachelor of science in electrical engineering degree are grouped into four interrelated curricular blocks. The foundations block includes courses in the natural sciences, mathematics, and computer science.. The electrical or computer engineering fundamentals blocks include the 100, 200, and 300 level ECEGR and CSSE courses that are required in the two majors. The fundamentals block provides the basis for all advanced studies in the field. The advanced ECEGR block includes elective courses and the three-quarter senior design sequence. The advanced block allows students an opportunity to explore their individual interests within the field. Finally, the university core exposes students to a broad range of the humanities, social sciences, and fine arts.

Bachelor of Science in Electrical Engineering
Major in Electrical Engineering

In order to earn the bachelor of science in electrical engineering degree with a major in electrical engineering, students must complete a minimum of 180 quarter credits with cumulative and major/department grade point averages of 2.50 or greater. Courses must include the following:

I. Core Curriculum Requirements

Students majoring in electrical engineering must complete a minimum of 50 credits in the core curriculum, including:

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Introduction to Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	5
PHIL 220	**Philosophy of the Human Person**	5
Social Science I		5

Choose one of the following two options: 5

Social Science II
Fine Arts (one approved 5 credit course, see course descriptions)

Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied by ECEGR 487, 488, and 489.
Senior synthesis satisfied by ECEGR 487, 488, and 489.

II. Major Requirements

A minimum of 70 credits of electrical and computer engineering, including:

ECEGR 100	**Intro. to Electrical and Computer Engineering Design** 2
ECEGR 101	**Engineering Problem Solving With MATLAB** 3
ECEGR 201	**Digital Operations and Computation** 4
ECEGR 210	**Electrical Circuits I** 5
ECEGR 211	**Electrical Circuits II** 4
ECEGR 227	**Electrical Circuits Laboratory** 2
ECEGR 312	**Linear System Analysis** 4
ECEGR 317	**Signals and Systems Laboratory** 2
ECEGR 320	**Electronics I** 4
ECEGR 321	**Electronics II** 4
ECEGR 328	**Electronic Circuits Laboratory** 2
ECEGR 487	**Engineering Design I** 3
ECEGR 488	**Engineering Design II** 4
ECEGR 489	**Engineering Design III** 3
ECEGR	**Upper-division electives (five lecture courses)** 20
ECEGR	**Upper-division electives (two laboratories)** 4

III. Other Major Department Requirements

A minimum of 60 credits including:

CSSE 151	**Fundamentals of Computer Science I** 5
MATH 134	**Calculus I** 5
MATH 135	**Calculus II** 5
MATH 136	**Calculus III** 5
MATH 232	**Multivariable Calculus** 3
MATH 233	**Linear Algebra** 3
MATH 234	**Differential Equations** 4
MATH 244	**Prob. and Statistics for the Sciences and Engineering** 5
PHYS 121	**Mechanics** 5
PHYS 122	**Electricity and Magnetism** 5
PHYS 123	**Waves and Optics** 5
PHYS 330	**Electromagnetic Field Theory** 5
Elective	**Science/Engineering** 5

Bachelor of Science in Electrical Engineering
Major in Electrical Engineering with a
Specialization in Computer Engineering

In order to earn the bachelor of science in electrical engineering degree with a specialization in computer engineering, students must complete a minimum of 180 quarter credits with cumulative and departmental/major grade point averages of 2.50 or greater. Courses must include the following:

I. Core Curriculum Requirements

Students majoring in electrical engineering with a specialization in computer engineering must complete a minimum of 50 credits in the core curriculum, including:

ENGL 110	**College Writing: Inquiry and Argument** 5
PHIL 110	**Introduction to Philosophy and Critical Thinking** 5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature** 5
PHIL 220	**Philosophy of the Human Person** 5
Social Science I	 5

Choose one of the following two options: 5

Social Science II

Fine Arts (one approved 5 credit course, see course descriptions)

Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied by ECEGR 487, 488, and 489.
Senior synthesis satisfied by ECEGR 487, 488, and 489.

II. Major Requirements

78 to 81 credits, including:

ECEGR 100	**Intro. to Electrical and Computer Engineering Design** 2
ECEGR 101	**Engineering Problem Solving With MATLAB** 3
CSSE 151	**Fundamentals of Computer Science I** 5
CSSE 152	**Fundamentals of Computer Science II** 5
CSSE 250	**Data Structures** 5
CSSE 340	**Operating Systems** 5
ECEGR 201	**Digital Operations and Computation** 4
ECEGR 210	**Electrical Circuits I** 5
ECEGR 211	**Electrical Circuits II** 4
ECEGR 227	**Electrical Circuits Laboratory** 2
ECEGR 304	**Microprocessor Design** 4
ECEGR 320	**Electronics I** 4
ECEGR 321	**Electronics II** 4
ECEGR 328	**Electronic Circuits Laboratory** 2
ECEGR 487	**Engineering Design I** 3
ECEGR 488	**Engineering Design II** 4
ECEGR 489	**Engineering Design III** 3
ECEGR*	**Electives** .... **12 to 15**
ECEGR*	**Elective Lab** 2

*Allowable electives consist of ECEGR and/or CSSE approved by the computer engineering program director. A list of these can be found in the Electrical and Computer Engineering Student Handbook. Electives must be selected to ensure that the student has the required 180 credits for graduation.

III. Other Program Requirements

A minimum of 50 credits including:

MATH 134	**Calculus I** 5
MATH 135	**Calculus II** 5
MATH 136	**Calculus III** 5
MATH 222	**Discrete Structures** 5
MATH 232	**Multivariable Calculus** 3
MATH 233	**Linear Algebra** 3

MATH 234	**Differential Equations**... 4
MATH 244	**Prob. and Statistics for the Sciences and Engineering** 5
PHYS 121	**Mechanics** 5
PHYS 122	**Electricity and Magnetism** 5
PHYS 123	**Waves and Optics**.. 5

Minor in Electrical Engineering

To earn a minor in electrical engineering, students must complete a minimum of thirty credits from among the following:

ECEGR 100	**Intro. to Electrical and Computer Engineering Design** 2
ECEGR 101	**Engineering Problem Solving With MATLAB**.. 3
ECEGR 201	**Digital Operations and Computation**... 4
ECEGR 210	**Electrical Circuits I** 5
ECEGR 211	**Electrical Circuits II** 4
ECEGR 227	**Electrical Circuits Laboratory**... 2
ECEGR 312	**Linear System Analysis**.. 4
ECEGR 317	**Signals and Systems Laboratory**... 2
ECEGR 320	**Electronics I** 4
ECEGR 321	**Electronics II** 4
ECEGR 328	**Electronic Circuits Laboratory**.. 2

See policy for minors (84-1) for more information.

Electrical Engineering Courses

ECEGR 100   Intro. to Electrical and Computer Engineering Design 2
Introduction to electrical and computer engineering design and principles of technical communication through a hands-on robotics design project in which teamwork is emphasized. Design process, engineering tools, creative and analytical thinking, professionalism, and open-ended problems with interdisciplinary content. Grading based on the quality of deliverables and presentation of design results through written, oral, and graphical communication. Open to all university students. (fall, winter)

ECEGR 101   Engineering Problem Solving With MATLAB.. 3
Laboratory oriented course designed to introduce students to programming in MATLAB. The emphasis is on developing the confidence and skill necessary to generate readable, compact, and verifiably correct MATLAB programs for obtaining numerical solutions to a wide range of engineering problems and displaying the results with fully annotated graphics. Topics include introduction to the MATLAB environment, matrix manipulation and computation, MATLAB programming language, writing functions and scripts, and production of 2D and 3D graphical output. Co-requisite: MATH 134. (fall, winter)

ECEGR 201   Digital Operations and Computation... 4
Digital processing of information and data, number-systems, Boolean algebra; design of hardware for registers, counting, and arithmetic operations; organization of computers, storage, and input/output. Introduction to simple logic circuits. Elementary concepts of programming, assembly language, and computer simulation. Open to all university students. (fall, winter)

ECEGR 210   Electrical Circuits I 5
Fundamental concepts and units, Kirchhoff's laws, mesh and node analysis, equivalent circuits, linearity and superposition; first and second order circuits; natural and forced responses, initial conditions; sinusoidal analysis. Co-requisite: MATH 233. Prerequisite: PHYS 122. (winter, spring)

ECEGR 211   Electrical Circuits II **4**

Phasors and impedance; Laplace transforms; system functions and the s-plane; frequency response description, Bode diagrams; AC power; two-port analysis; introduction to the digital computer in circuit analysis and design. Co-requisites: ECEGR 101 and MATH 234. Prerequisite: ECEGR 210. (fall, spring)

ECEGR 227   Electrical Circuits Laboratory **2**

A laboratory covering principles of electrical and electronic circuits. Test instrumentation and general laboratory practice. Technical communications. The course culminates in a class-wide team project. A one-hour lecture and one four-hour laboratory per week. Co-requisite: ECEGR 211. (fall, spring)

ECEGR 296   Directed Study .... **1 to 5**

ECEGR 304   Microprocessor Design **4**

Design of digital components and subsystems of a typical microprocessor. Assembly language programming, memory access, Instruction processing, peripherals. Three lectures and one four-hour laboratory per week. Prerequisites: ECEGR 201, CSSE 151, and junior candidacy. (winter)

ECEGR 312   Linear System Analysis **4**

Linear systems and response type classifications. Time-domain and frequency-domain signal representations. System functions. Impulse response. Convolution. Fourier series and transforms. Signal spectra. Prerequisite: ECEGR 211, MATH 234, and junior candidacy. (fall, winter)

ECEGR 315   Elements of Electrical Engineering **5**

An introduction to major areas of electrical engineering. Topics are selected from basic circuit theory; linear systems; electronics; digital logic; electromagnetics; and energy conversion and power. Intended for engineering and natural science students not majoring in electrical engineering; Prerequisite: MATH 234 and PHYS 122. (winter)

ECEGR 317   Signals and Systems Laboratory **2**

Signal acquisition and analysis. Spectral content of signals and frequency response behavior of systems. Use of spectral and network analyzers. Use of MATLAB and other engineering analysis software. A one-hour lecture and one four-hour laboratory session per week. Co-requisite: ECEGR 312. Prerequisite: ECEGR 227. (fall, winter)

ECEGR 320   Electronics I **4**

Diodes and bipolar and field effect transistor characteristics. Analysis and design of elementary electronic circuits including diode circuits, transistor amplifiers, and ideal operational amplifier circuits. Prerequisite: ECEGR 211 and junior candidacy. (fall, winter)

ECEGR 321   Electronics II **4**

Differential and multistage transistor amplifiers. Classes of amplifiers. Frequency response of transistor circuits. Introduction to feedback. Internal circuitry of the operational amplifier. Operational amplifier circuits. Prerequisite ECEGR 320. (winter, spring)

ECEGR 328   Electronic Circuits Laboratory **2**

Continuation of ECEGR 227. Investigation of electronic circuits focusing on the design of a discrete component operational amplifier. Prerequisite: ECEGR 227. Co-requisite: ECEGR 321. (winter, spring)

ECEGR 331   Distributed Systems **4**

Analysis of distributed systems; steady-state and transient analysis of loss-less lines, lossy lines; waveguides. Prerequisite: ECEGR 211, PHYS 123, and junior candidacy.

ECEGR 360   Communication Systems **4**

Analysis and design of signal transmission systems that include amplitude, phase, frequency, and pulse modulation. Subsystem synthesis and design with comparative analysis. Communication in the presence of noise. Prerequisites: ECEGR 312 and MATH 244.

ECEGR 391-393   Special Topics..**1 to 5**

ECEGR 396   Directed Study ....**1 to 5**

ECEGR 401   VLSI: VHDL.. **4**

VHDL (Very high speed integrated circuit Hardware Description Language) as a digital system description tool. Digital design principles and their application to programmable logic devices. Use of VHDL as a design tool for PLD's is emphasized. Significant laboratory time outside of class is required. Prerequisite: ECEGR 201 and junior candidacy.

ECEGR 403   Digital Signal Processing **4**

Linear, time invariant, discrete systems; finite moving average and recursive digital filters; Z-transform; discrete Fourier transform; fast Fourier transform. Prerequisite: ECEGR 312.

ECEGR 404   Introduction to VLSI Circuit Design **4**

An introduction to the design of very large scale integrated (VLSI) circuits using silicon CMOS process technology and CAD software. Aspects of manufacturing, design, and testing are covered in lecture. The laboratory introduces students to professional-level software and culminates in a major circuit design. Three lectures and one three-hour laboratory per week. Prerequisite: ECEGR 201 and ECEGR 321.

ECEGR 405   Advanced Digital Design **4**

Microprocessor-based systems design procedures; LSI circuit specifications and interconnect design; programmable logic; logic simulation; prototype construction; system debug techniques; hands-on design carried out in teams. Prerequisites: ECEGR 201 and ECEGR 304.

ECEGR 406   Introduction to Digital Image Processing **4**

Introduction to fundamental principles and techniques for digital image processing including image analysis, feature extraction, segmentation, enhancement, restoration, and compression. Hands-on experience through MATLAB laboratory exercises and projects.

ECEGR 407   Digital Signal Processing Laboratory.. **2**

Use of modern Digital Signal Processing (DSP) software development systems. Debugging and analysis of program operation on DSP integrated circuits. DSP IC architectures. Analysis of test data in time and frequency domains. Prerequisite: ECEGR 312. Co-requisite: ECEGR 403.

ECEGR 414   Active Networks and Filters **4**

Design of active filters. Operational amplifier circuits. Approximation of frequency response characteristics. Sensitivity. Frequency transformations. Active two-port networks. Simulation of passive elements. Switched capacitor filters. Prerequisite: ECEGR 312.

ECEGR 421   Analog CMOS Electronics **4**

Analog CMOS circuits including current sources, voltage references, and basic amplifier stages used in integrated circuits, the internal circuitry of operational amplifiers, and analog-to-digital and digital-to-analog converters. Feedback. Fundamentals of integrated circuit layout and fabrication. Prerequisite: ECEGR 321.

ECEGR 422   Electronics III **4**

A continuation of Electronics II covering topics selected from, but not limited to, feedback and stability, active filters, oscillators, data converters, signal generators, and digital electronics. Prerequisite: ECEGR 321.

ECEGR 424   Power Electronics **4**

Basic topologies and operating principles of switching power converters. Half-wave, bridge, and polyphase rectifier circuits. Phase control converters. Output control and dynamic models. Prerequisite: ECEGR 312 and ECEGR 320.

ECEGR 428   **Advanced Electronics Laboratory** 2

A special topics electronics laboratory focusing on practical applications in electrical and computer engineering. Design projects vary depending on the interests of the students and instructor. The iterative process of design, simulation, fabrication, and testing is emphasized. A one-hour lecture and one four-hour laboratory session per week. Prerequisites: ECEGR 321 and ECEGR 328. (May be retaken for credit with permission of the department chair.)

ECEGR 432   **Microwave Systems** 4

Propagation of electromagnetic waves and interaction with materials, guided waves, and passive and active devices, microstrip and integrated circuits. Prerequisite: ECEGR 312 and PHYS 330.

ECEGR 433   **Introduction to Antennas** 4

Electromagnetic waves and radiating systems used in telecommunications. Software simulation of antenna radiation patterns. Frequency spectra used in modern communications and their effect on antenna design. Prerequisite: ECEGR 312 and PHYS 330.

ECEGR 437   **Antennas Laboratory** 2

A laboratory covering the measurement and simulation of wire and aperture antenna radiation patterns. Co-requisite: PHYS 330.

ECEGR 440   **Control Systems** 4

Fundamentals of classical and modern system theory; analysis and design of closed-loop systems with emphasis on stability and transient response using Nyquist, Bode, root-locus, and state-space techniques. Prerequisite: ECEGR 312.

ECEGR 450   **Electromechanical Energy Conversion** 4

Electromechanical energy conversion principles and design. Application and details of electromechanical devices, such as relays, transformers, and rotating machinery. Prerequisite: ECEGR 211 and junior candidacy.

ECEGR 451   **Power Systems** 4

Analysis of power systems: symmetrical components, power system parameters, steady-state operation, symmetrical and non-symmetrical faults. Prerequisite: ECEGR 450.

ECEGR 457   **Electromechanical Energy Conversion Laboratory** 2

A laboratory covering the principles and practice of electromechanical energy conversion devices. Co-requisite: ECEGR 450.

ECEGR 461   **Data Communications** 4

An introduction to the concepts and methods of data communication. Systems, protocols, and controls used in data transfer. Media employed for data transmission and multiplexing techniques. Long-range and local networks used in data and computer communications. Prerequisite: ECEGR 201 and junior candidacy or permission.

ECEGR 462   **Modern Optics** 4

Introduction to modern optics consisting of ray optics; scalar wave optics; diffraction; interferometry; vector wave optics and polarization; Gaussian beam optics; Fourier optics, including image processing, spatial filtering, and holography; optical waveguides and fibers; optical resonators; laser amplifiers and systems; semiconductor lasers and detectors; optical switching and computing. Optional labs in holography and fiber optics. Prerequisites: ECEGR 312 or PHYS 205; PHYS 330.

ECEGR 463   **Wireless Communications Systems** 4

An introduction to issues and problems associated with modern wireless communications systems. Radio wave systems. Multipath and fading. Frequency planning. Cellular communications. Registration. Prerequisite: ECEGR 312 and PHYS 123.

ECEGR 467　　　　　**Communications Laboratory**.. **2**

A laboratory covering basic principles of encoding, modulation, and transmission of electronic signals. One-hour lecture and one four-hour laboratory per week. Co-requisite: ECEGR 360.

ECEGR 487　　　　　**Engineering Design I**.. **3**

ECEGR 488　　　　　**Engineering Design II**... **4**

ECEGR 489　　　　　**Engineering Design III** **3**

A year-long capstone team design project that draws upon all of the student's previous experience, both technical and non-technical. Projects require students to investigate and apply concepts not covered in course work and to master engineering tools needed to complete the assigned task. Particular emphasis is placed upon project organization and management, principles of engineering design, oral and written communication, and professionalism and ethics. In ECEGR 487, student teams are formed and industrially-sponsored design problems are assigned. Project proposals are written, critiqued, and presented. In ECEGR 488 and 489, problem solutions are developed and implemented, culminating in a formal presentation of results. In addition to regularly-scheduled lectures, students are expected to devote significant time to design team activities. The three courses must be taken as a continuous sequence. The Engineering Design sequence fulfills the interdisciplinary and synthesis requirements of the university core. Prerequisite: advanced junior or senior standing in engineering. (487, fall; 488, winter; 489, spring)

ECEGR 491-493　　　**Special Topics**... **1 to 5**

ECEGR 496　　　　　**Independent Study** .... **1 to 5**

ECEGR 497　　　　　**Directed Reading** .... **1 to 5**

ECEGR 498　　　　　**Directed Research**.. **1 to 5**

Independent work by student on topic of mutual interest to student and an instructor. Enrollment is limited and open only to students who have agreed upon a proposed topic or course of study with the instructor. May be used as an advanced elective with departmental permission.

Environmental Science

Jennifer Sorensen, PhD, Director

Objectives

The environmental science degree offers a broad background in the basic and applied sciences, with foundation courses in general biology and ecology, general and organic chemistry, and environmental engineering. The major is partially self-designed, allowing each student to take additional upper division courses in areas of interest, such as water resources, marine biology, or chemical analysis of environmental samples.

The Bachelor of Science in Environmental Science is also compatible with obtaining a minor in biology, chemistry, or environmental engineering. The balance of scientific/technical training in the major and liberal arts in the core provides sound preparation for environmental field work, law school, advocacy, or graduate school in a variety of disciplines. The major can also be configured to meet pre-medical requirements.

Degree Offered
Bachelor of Science in Environmental Science

Major Offered
Environmental Science

Bachelor of Science in Environmental Science

In order to earn the bachelor of science in environmental science degree, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5
HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	**5**

Fine Arts (one approved 5 credit course; see course descriptions) 5
PHIL 220	**Philosophy of the Human Person**	**5**

Social Science I 5
Social Science II (ECON 271 or 272 recommended) 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary .... 3 to 5
Senior Synthesis (Fulfilled by ISSC 489 and 490) 3

II. Major Requirements

98 credits in science, engineering and mathematics including:

MATH 134	**Calculus I**..	5
MATH 135	**Calculus II**...	5
MATH 244	**Probability and Statistics**...	5
BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
BIOL 162	**Biology II: Evolution and Ecology**	4
BIOL 172	**Biology II Lab**	1
BIOL 163	**Biology III: Physiology and Development**.................................	4
BIOL 173	**Biology III Lab**	1
BIOL 470	**General Ecology**...	5
CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry I Lab**	1
CHEM 122	**General Chemistry II**	4
CHEM 132	**General Chemistry II Lab**	1
CHEM 123	**General Chemistry III**	4
CHEM 133	**General Chemistry III Lab**	1
CHEM 231	**Fundamental Organic Chemistry I**	4
CHEM 241	**Fundamental Organic Chemistry I Lab**.....................................	2
CHEM 232	**Fundamental Organic Chemistry II**	4
CHEM 242	**Fundamental Organic Chemistry II Lab**....................................	2
PHYS 105	**Mechanics**	5
PHYS 106	**Wave, Sound, Electricity and Magnetism**.................................	5
CEEGR 341	**Biological Principles for Environmental Engineers**...................	5
CEEGR 342	**Environmental Engineering Chemistry**	4
CEEGR 351	**Engineering Geology**	4
CEEGR 473	**Principles of Environmental Engineering**	5
CEEGR 476	**Environmental Law and Impact Studies**	4
CEEGR 486	**Green Engineering**..	4

III. Other Major Department Requirements

18 credits in science, environmental, and engineering electives from the following: (Additional prerequisites may be necessary for some courses.) 18

CHEM 319	**Quantitative Analysis (5)**
CHEM 454	**Biochemistry I (3)**
CEEGR 105	**Civil Engineering Graphics and Communication (3)**
CEEGR 302	**Engineering Economy (3)**
CEEGR 311	**Engineering Measurements (4)**
CEEGR 474	**Water Supply and Wastewater Engineering (5)**
CEEGR 475	**Hazardous Waste Engineering (5)**
MEGR 105	**Engineering Graphics and Design (3)**
BIOL 235	**Invertebrate Zoology (5)**
BIOL 240	**Genetics (5)**
BIOL 252	**Taxonomy of Flowering Plants (5)**

BIOL 275   **Marine Biology (5)**
BIOL 300   **Microbiology (5)**
BIOL 385   **Plant Physiology (5)**

NOTE: Credit for CEEGR 105 and MEGR 105 cannot both be applied to the major.

No more than 5 credits of elective from the following environmental classes:
PLSC 300   **Environmental Politics**
ECON 468   **Natural Resources and Environmental Economics**
HIST 351   **Environmental History**
PHIL 378   **Environmental Philosophy**
THRS 324   **Religion and Ecology**
ISSC 482   **Global Climate Change**

Note about minors: A minimum of 30 credits in biology or environmental engineering will constitute a minor in that area, 35 credits for chemistry. Only one minor can be earned for each degree. A biology minor would require 10 credits of biology from the elective list. A minor in chemistry would require CHEM 319 and additional chemistry credits to total 35. A minor in environmental engineering would require 4 civil engineering credits from the elective list.

General Science

Jennifer Sorensen, PhD, Director

Objectives

The general science program provides a broad background in the basic sciences, and allows flexibility for students interested in interdisciplinary fields involving science. The program can be customized for premedical, predental, and other allied health studies; a preprofessional specialization is offered to assist in preparation for health professions. Other curricula can be customized for a student in consultation with the advisor.

Degree Offered
Bachelor of Science in General Science

Major Offered
General Science

Specialization Offered
Preprofessional

Bachelor of Science in General Science

In order to earn the bachelor of science in general science degree with a major in general science, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses 5
HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**	**5**

Fine Arts (one approved 5 credit course; see course descriptions)... **5**
PHIL 220	**Philosophy of the Human Person**	**5**

Social Science I **5**
Social Science II (different discipline from Social Science I).. **5**
Theology and Religious Studies Phase II (200-299) **5**
Ethics (upper division)... **5**
Theology and Religious Studies Phase III (300-399) **5**
Interdisciplinary satisfied within major
Senior Synthesis (Fulfilled by ISSC 489 and 490) **3**

II. Major Requirements

95 credits in mathematics, science, engineering, and computer science including:

*Primary concentration **30**
*Secondary concentration.. **20**
(May not include introductory mathematics and science courses)
Science Electives (see department)...................................... **0 to 15**

Courses used to satisfy the following requirements may, in some cases, be applied toward the primary or secondary concentrations.

Ten credits in chemistry, including:

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
CHEM 122	**General Chemistry II**	4
CHEM 132	**General Chemistry Lab II**	1
CSSE	**Elective**	5

Interdisciplinary Science (300-400 level) .... **.3 to 5**

Choose two of the following five options: 10

a. BIOL 161	**Biology I: Molecular and Cellular Biology**	
BIOL 171	**Biology I Lab**	
b. BIOL 162	**Biology II: Evolution and Ecology**	
BIOL 172	**Biology II Lab**	
c. BIOL 163	**Biology III: Physiology and Development**	
BIOL 173	**Biology III Lab**	
d. BIOL 200	**Anatomy and Physiology I**	
e. BIOL 210	**Anatomy and Physiology II**	

Choose option a, b, c, or d... 10

a. MATH 120	**Precalculus: Algebra**	
MATH 131	**Calculus for Life Sciences (note: MATH 121 is co-requisite)**	
b. MATH 118	**College Algebra for Business**	
MATH 130	**Elements of Calculus for Business**	
c. MATH 134	**Calculus I (note: MATH 121 is co-requisite)**	
MATH 135	**Calculus II**	
d. MATH 131	**Calculus for Life Sciences (note: MATH 121 is co-requisite)**	
PSYC 201	**Statistics for Non-Majors**	

Choose option a or b... 10

a. PHYS 105	**Mechanics**	
PHYS 106	**Waves, Sound, Electricity and Magnetism**	
b. PHYS 121	**Mechanics**	
PHYS 122	**Electricity and Magnetism**	

NOTE: 1. At least 20 credits of the 95 general science required credits must be from 300- or 400-level classes. An additional 10 credits must be from 300-level, 400-level, or approved 200-level courses. This may require prerequisites beyond the minimal degree requirements. The approved 200-level courses are BIOL 240, CEEGR 221/222, CHEM 231/241, CHEM 232/242, MATH 232, MATH 233, MATH 234, MEGR 210, MEGR 230, MEGR 281, PHYS 203, PHYS 204, PHYS 205, and PSYC 240. ISSC 489/490 does not count toward major or upper-division science credits. 2. No more than 15 credits from this major will be counted toward any minors. 3. Students must earn at least a C- in 100 and 200-level science and mathematics courses that apply to the major.

*Fields allowed: biology, chemistry, diagnostic ultrasound, engineering (all engineering courses are one field), mathematics, physics, computer science and interdisciplinary science. See department for approved science electives.

Bachelor of Science in General Science
Preprofessional Specialization

This track is for students interested in preparing for post-baccalaureate programs in professions such as medicine, dentistry, pharmacy, osteopathic medicine, and veterinary medicine. In order to earn the bachelor of science in general science degree in the preprofessional track, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	5
Fine Arts (one approved 5 credit course; see course descriptions)		5
PHIL 220	**Philosophy of the Human Person**	5
Social Science I		5
Social Science II (different discipline from Social Science I)		5
Theology and Religious Studies Phase II (200-299)		5
Ethics (PHIL 352 recommended)		5
Theology and Religious Studies Phase III (300-399)		5
Interdisciplinary satisfied within major		
Senior Synthesis (fulfilled by ISSC 489 and 490)		3

II. Major Requirements

96 credits in mathematics, science, and computer science, including:

BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
BIOL 162	**Biology II: Evolution and Ecology**	4
BIOL 172	**Biology II Lab**	1
BIOL 163	**Biology III: Physiology and Development**	4
BIOL 173	**Biology III Lab**	1

Choose any three among the following six biology courses: 15

BIOL 240	**Genetics**	
BIOL 300	**Microbiology**	
BIOL 310	**Developmental Biology**	
BIOL 325	**Comparative Anatomy of the Vertebrates**	
BIOL 388	**Animal Physiology**	
BIOL 485	**Cell Biology**	

CHEM 121	**General Chemistry I**	4
CHEM 131	**General Chemistry Lab I**	1
CHEM 122	**General Chemistry II**	4

CHEM 132	General Chemistry Lab II	1
CHEM 123	General Chemistry III	4
CHEM 133	General Chemistry Lab III	1
CHEM 335	Organic Chemistry I	3
CHEM 345	Organic Chemistry Lab I	2
CHEM 336	Organic Chemistry II	3
CHEM 346	Organic Chemistry Lab II	2
CHEM 337	Organic Chemistry III	4
CHEM 347	Organic Chemistry Lab III	2
CSSE	Elective	5

Interdisciplinary Science (300-400 level) .... **3 to 5**

Choose series a or b 15

a. PHYS 105	Mechanics
PHYS 106	Waves, Sound, Electricity and Magnetism
PHYS 107	Thermodynamics, Optics, and Modern Physics
b. PHYS 121	Mechanics
PHYS 122	Electricity and Magnetism
PHYS 123	Waves and Optics

Choose option a, b, c, or d 10

a. MATH 118	College Algebra for Business
MATH 130	Elements of Calculus for Business
b. MATH 120	Precalculus: Algebra
MATH 131	Calculus for Life Sciences (MATH 121 is co-requisite)
c. MATH 131	Calculus for Life Sciences (MATH 121 is co-requisite)
PSYC 201	Statistics for Non-Majors
d. MATH 134	Calculus I (MATH 121 is co-requisite)
MATH 135	Calculus II

NOTE: 1. CHEM 454, CHEM 455, and CHEM 456 are strongly recommended as electives. 2. Students interested in preparing for professions such as chiropractic medicine, podiatry, and physical therapy should consult with an advisor to determine appropriate courses. 3. No more than 15 credits from this major will be counted toward any minors. 4. Students must earn at least a C- in 100 and 200-level science and mathematics courses that apply to the major.

Interdisciplinary Science Courses

ISSC 100   **Introduction to Environmental Science** **2**
Investigation of some significant topics in environmental science at an introductory level and research of current issues in the literature. Introduction to environmental science career opportunities through hands-on demonstrations, lectures, and site visits with professionals in the field. Open to all university students.

ISSC 120   **Introduction to Geology** **5**
Study of the principles of modern geology, with consideration of both the physical and historical aspects. Topics will include modern plate theory, tectonics, uniform processes, and the fossil record. Four hours of lecture and three hours of laboratory per week. Arranged field trips. (fall, winter, spring) Core lab science.

ISSC 191-193   **Special Topics** .... **1 to 5**

ISSC 201   **Digital Operations and Computation**.. **5**

Digital processing of information and data, number-systems, Boolean algebra; design of hardware for registers, counting, and arithmetic operations; organization of computers, storage, and input/output. Introduction to simple logic circuits. Elementary concepts of programming, assembly language, and computer simulation. Open to all university students. Core lab science. Cross-listed with ECEGR 201. (fall, winter)

ISSC 207   **Air and Water**... **5**

Dynamics of air and water systems. Consideration of the causes and control of air and water pollution. Monitoring and standards for clean air and water. The role of technology in the deterioration of air and water quality. Four hours of lecture and three hours of laboratory per week. Core lab science. Prerequisite: Core math. (winter or spring)

ISSC 291-293   **Special Topics**.. **1 to 5**

ISSC 296   **Directed Study** .... **1 to 5**

ISSC 480   **The Human Response to Science and Technology** **5**

A comparative-historical approach to the scientization of culture and its contemporary and projected consequences; critical evaluation of competing claims about science and technology as enlightening allies of human progress; a personal search for appropriate intellectual and ethical perspectives on science as a way of knowing and on technology as a way of living. Seminar format; guest lectures; small-group paper conferences; student-led seminars. Interdisciplinary core option. Prerequisites: junior standing or higher, PHIL 220, HIST 120 or 121.

ISSC 481   **To Feed the World** **5**

An interdisciplinary approach to the history, production, and distribution of food from the perspectives of paleontology, anthropology, biology, chemistry, and the social sciences; modes of scientific examination and interpretation are explored; interrelationships of science, technology, and human needs are emphasized. Active participation by students; lectures, movies, and small group discussions. Prerequisite: Phase II of core. Interdisciplinary core option.

ISSC 482   **Global Climate Change** **5**

The science of global climate change and its effects on the environment, society and political decisions. Consideration of the main elements of the climate, measurement and consequences of change, evidence for past change and predictive tools for future change. Critical evaluation of current scientific literature, small group discussion and presentation. Prerequisites: Core lab science, junior standing. Interdisciplinary core option.

ISSC 483   **Interdisciplinary Core Course** .... **3 to 5**

ISSC 489   **Senior Synthesis**.. **2**

Initiation of an independent literature or laboratory research project. Searching, reading, and synthesizing scientific literature. Consideration of relationship between major, Core, and professional goals. Development of student portfolio. Oral presentation and written report. Along with ISSC 490, part of the senior synthesis requirement for general science and environmental science majors. Prerequisite: general science or environmental science major. (winter)

ISSC 490   **Senior Synthesis Seminar** **1**

Continuation of the project developed in ISSC 489, including final oral and written presentations of the research. Along with ISSC 489, part of the senior synthesis requirement for general science and environmental science majors. Prerequisite: ISSC 489. (spring)

ISSC 491-493   **Special Topics**.. **1 to 5**

ISSC 496   **Independent Study** .... **1 to 5**

ISSC 497   **Directed Reading** .... **1 to 5**

ISSC 498   **Directed Research**... **1 to 5**

Mathematics

Jeffrey Boersema, PhD, Chair

Objectives

The Mathematics Department offers three distinct programs. The first two are very flexible programs that provide for work in a secondary field and lead to either the bachelor of arts or the bachelor of science degree. The bachelor of arts degree includes a choice of a specialization in humanities for teaching. The third program, leading to the bachelor of science in mathematics degree, prepares the student for advanced study and professional work in mathematics. For this third degree program, the student chooses either a pure mathematics or an applied mathematics specialization.

Degrees Offered

Bachelor of Arts
Bachelor of Science
Bachelor of Science in Mathematics

Majors Offered

Mathematics
Mathematics, with specialization in Applied Mathematics
Mathematics, with specialization in Humanities for Teaching
Mathematics, with specialization in Pure Mathematics

Minor Offered

Mathematics

Bachelor of Arts
Major in Mathematics

In order to earn the bachelor of arts degree with a major in mathematics, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00. This degree is particularly appropriate for students who intend to teach mathematics at the K-12 level. The bachelor of arts degree includes either the standard core option with electives or the specialization in humanities for teaching. Either option can prepare students to enter teacher certification and master degree programs in education. The program leading to the bachelor of arts degree does not confer a teaching credential, but is preparation for someone who intends to enter a master's degree in teaching program. The specialization in humanities for teaching option is for entering freshmen only. Students must choose one of the following two options:

Bachelor of Arts
Major in Mathematics
Standard Core Option

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	**5**
PHIL 110	**Introduction to Philosophy and Critical Thinking**	**5**

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120   **Introduction to Literature** 5
Lab Science (fulfilled in major)
Fine Arts (one approved 5 credit course; see course descriptions) 5
PHIL 220   **Philosophy of the Human Person** 5
Social Science I   5
Social Science II (different discipline from Social Science I) 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   .... 3 to 5
Senior Synthesis satisfied by MATH 488, 489, 490

II. Major Requirements

50 credits of mathematics, including:

MATH 134	**Calculus I**	**5**
MATH 135	**Calculus II**	**5**
MATH 136	**Calculus III**	**5**
MATH 232	**Multivariable Calculus**	**3**
MATH 233	**Linear Algebra**	**3**
MATH 234	**Differential Equations**	**4**
MATH 310	**Introduction to Advanced Mathematics**	**5**
MATH 488	**Senior Synthesis I**	**2**
MATH 489	**Senior Synthesis II**	**2**
MATH 490	**Senior Synthesis III**	**1**
MATH	**Electives (300 or above)**	**10**

Choose one of the following two courses: 5

MATH 411	**Introduction to Abstract Algebra I**
MATH 431	**Introduction to Real Analysis I**

III. Other Major Department Requirements

Electives **18**
Computer science, economics, psychology, and/or natural science approved by advisor, including at least one core lab science and one computer application or programming course.

NOTE: A maximum total of 5 credits of Directed Research or Undergraduate Research may be used to satisfy the math elective requirement.

Bachelor of Arts
Major in Mathematics
Specialization in Humanities for Teaching

In order to earn the bachelor of arts degree with a major in mathematics and specialization in humanities for teaching, students must complete a minimum of 180 credits, with a cumulative grade point average of 2.50, and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150	**Composition: Language and Thought**	5
HUMT 151	**Composition: Language and the Arts**	5
HUMT 152	**Logic, Ethics and Discernment**	5
HUMT 161	**Humanities: Introduction to Tutoring**	2
HUMT 162	**Humanities: Introduction to Tutoring**	1
HUMT 163	**Humanities: Introduction to Tutoring**	1
HUMT 171	**Proseminar: Humanistic Foundations of Education**	5
HUMT 180	**Socio-Cultural Transformations I**	5
HUMT 181	**Socio-Cultural Transformations II**	5
HUMT 182	**Socio-Cultural Transformations III**	5
HUMT 273	**Seminar on Secondary Education**	5
HUMT 274	**Supervised Internship in Secondary Education**	5
HUMT 301	**Perspectives on the Person I**	5
HUMT 302	**Perspectives on the Person II**	5
HUMT 371	**Education and the Polity**	5
HUMT 372	**Leadership and Teaching**	5
HUMT 380	**Cultural Interface**	5
HUMT 400	**Seminar on Contemporary Problems**	5
HUMT 471	**Jesuit Education**	5
HUMT 472	**Jesuit Education Practicum**	5
CISS 120	**Poverty in America**	5

Core Lab Science (fulfilled in major)

II. Major Requirements

50 credits of mathematics, including:

MATH 134	**Calculus I**	5
MATH 135	**Calculus II**	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
MATH 233	**Linear Algebra**	3
MATH 234	**Differential Equations**	4
MATH 244	**Probability and Statistics for the Sciences and Engineering**	5
MATH 310	**Introduction to Advanced Mathematics**	5
MATH 321	**Euclidean and Modern Geometries**	5
MATH 488	**Senior Synthesis I**	2
MATH 489	**Senior Synthesis II**	2
MATH 490	**Senior Synthesis III**	1

Choose one of the following two courses: 5

| MATH 411 | **Introduction to Abstract Algebra I** |
| MATH 431 | **Introduction to Real Analysis I** |

III. Other Major Department Requirements

Electives **18**

Computer science, economics, psychology, and/or natural science approved by advisor, including at least one core lab science and one computer application or programming course

NOTE: For a detailed description of this degree, see the introductory pages for the College of Science and Engineering.

Bachelor of Science
Major in Mathematics

In order to earn the bachelor of science degree with a major in mathematics, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

| ENGL 110 | **College Writing: Inquiry and Argument** .... **5** |
| PHIL 110 | **Introduction to Philosophy and Critical Thinking** .... **5** |

Choose one of the following two courses: 5

| HIST 120 | **Origins of Western Civilization** |
| HIST 121 | **Studies in Modern Civilization** |

| ENGL 120 | **Introduction to Literature** .... **5** |

Lab Science (fulfilled in major)

Fine Arts (one approved 5 credit course; see course descriptions) **5**

| PHIL 220 | **Philosophy of the Human Person** .... **5** |

Social Science I **5**

Social Science II (different discipline from Social Science I) **5**

Theology and Religious Studies Phase II (200-299) **5**

Ethics (upper division) **5**

Theology and Religious Studies Phase III (300-399) **5**

Interdisciplinary .... **3 to 5**

Senior Synthesis satisfied by MATH 488, 489, 490

II. Major Requirements

60 credits of mathematics, including:

MATH 134	**Calculus I** **5**
MATH 135	**Calculus II** **5**
MATH 136	**Calculus III** **5**
MATH 232	**Multivariable Calculus** **3**
MATH 233	**Linear Algebra** **3**
MATH 234	**Differential Equations** **4**
MATH 310	**Introduction to Advanced Mathematics** **5**
MATH 488	**Senior Synthesis I** **2**
MATH 489	**Senior Synthesis II** **2**

MATH 490	Senior Synthesis III	1
MATH	Electives (300 or above)	10

Choose one of the following three courses: 5

MATH 351	**Probability**
MATH 361	**Applied Mathematics I**
MATH 371	**Introduction to Numerical Methods**

Choose two of the following five courses: 10

MATH 411	**Introduction to Abstract Algebra I**
MATH 412	**Introduction to Abstract Algebra II**
MATH 431	**Introduction to Real Analysis I**
MATH 432	**Introduction to Real Analysis II**
MATH 461	**Applied Mathematics II**

III. Other Major Department Requirements

Electives **28**

Computer science, engineering, natural science, and/or social science approved by advisor, including at least one core lab science and one computer application or programming course.

NOTE: Under special circumstances, with approval from the department chair, MATH 244 may be substituted for MATH 351. A maximum total of 5 credits of Directed Research or Undergraduate Research may be used to satisfy the math elective requirement.

Bachelor of Science in Mathematics

In order to earn the bachelor of science in mathematics degree with a major in mathematics, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.50. Students must choose one of the following two options:

Pure Mathematics Specialization

This specialization is appropriate for any student planning to pursue graduate studies in mathematics.

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120	**Introduction to Literature**	5

Lab Science (fulfilled in major)

Fine Arts (one approved 5 credit course; see course descriptions) 5

PHIL 220	**Philosophy of the Human Person**	5

Social Science I 5

Social Science II (different discipline from Social Science I) 5

Theology and Religious Studies Phase II (200-299) 5

Ethics (upper division) 5

Theology and Religious Studies Phase III (300-399) 5

Interdisciplinary .... 3 to 5

Senior Synthesis satisfied by MATH 488, 489, 490

II. Major Requirements

70 to 72 credits in mathematics, including:

MATH 134	**Calculus I**...	5
MATH 135	**Calculus II**..	5
MATH 136	**Calculus III**	5
MATH 232	**Multivariable Calculus**	3
MATH 233	**Linear Algebra**..	3
MATH 234	**Differential Equations**..	4
MATH 310	**Introduction to Advanced Mathematics**	5
MATH 411	**Introduction to Abstract Algebra I**..	5
MATH 412	**Introduction to Abstract Algebra II**...	5
MATH 431	**Introduction to Real Analysis I**..	5
MATH 432	**Introduction to Real Analysis II**	5
MATH 488	**Senior Synthesis I**	2
MATH 489	**Senior Synthesis II**	2
MATH 490	**Senior Synthesis III**	1
MATH 499	**Undergraduate Research*** .... **0 to 2**
MATH	**Electives (numbered 222 or above)**.. **10**

Choose one of the following four courses:...5

MATH 244	**Fundamentals of Probability and Statistics**
MATH 351	**Probability**
MATH 361	**Applied Mathematics I**
MATH 371	**Introduction to Numerical Methods**

III. Other Major Department Requirements

Electives **18**

Computer science, economics and/or natural science approved by advisor, including at least one core lab science and one computer application or programming course.

NOTE: 1. In certain circumstances, with approval of the chair, 10 credits of upper-division work in computer science or a physical science may be substituted for 10 credits in mathematics. 2. *The MATH 499 requirement will be waived for a student who completes a National Science Foundation Research Experience for Undergraduates, senior design project, or approved research project in another department. 3. A maximum total of 5 credits of Directed Research or Undergraduate Research may be used to satisfy the math elective requirement.

Applied Mathematics Specialization

This specialization is appropriate for students planning to pursue a career in industry or to pursue graduate studies in applied mathematics.

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**..................................	5

Choose one of the following two courses:...5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120   **Introduction to Literature**.. 5
Lab Science   (fulfilled in major)
Fine Arts (one approved 5 credit course; see course descriptions).......................... 5
PHIL 220   **Philosophy of the Human Person**... 5
Social Science I   5
Social Science II (different discipline from Social Science I)..................................... 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division)... 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   ....3 to 5
Senior Synthesis satisfied by MATH 488, 489, 490

II. Major Requirements

70 to 72 credits in mathematics, including:

MATH 134   **Calculus I**.. 5
MATH 135   **Calculus II**... 5
MATH 136   **Calculus III** 5
MATH 232   **Multivariable Calculus** 3
MATH 233   **Linear Algebra**... 3
MATH 234   **Differential Equations**.. 4
MATH 310   **Introduction to Advanced Mathematics** 5
MATH 361   **Applied Mathematics I**... 5
MATH 371   **Introduction to Numerical Methods** 5
MATH 461   **Applied Mathematics II**.. 5
MATH 488   **Senior Synthesis I** 2
MATH 489   **Senior Synthesis II** 2
MATH 490   **Senior Synthesis III** 1
MATH 499   **Undergraduate Research*** .... 0 to 2
MATH   **Elective (222 or above)**.. 5

Choose one of the following three courses:.. 5
MATH 244   **Fundamentals of Probability and Statistics**
MATH 331   **Introduction to Complex Variables**
MATH 351   **Probability**

Choose two of the following four courses:... 10
MATH 411   **Introduction to Abstract Algebra I**
MATH 412   **Introduction to Abstract Algebra II**
MATH 431   **Introduction to Real Analysis I**
MATH 432   **Introduction to Real Analysis II**

III. Other Major Department Requirements

PHYS 121   **Mechanics** 5

Electives 13
Computer science, economics, and/or natural science approved by advisor, including a computer application or programming course.

NOTE: 1. In certain circumstances, with approval of the chair, 10 credits of upper division work in computer science or a physical science may be substituted for 10 credits in mathematics. 2. *The MATH 499 requirement will be waived for a student who completes a National Science Foundation Research Experience for Undergraduates, senior design project, or approved research project in another department. 3. A

maximum total of 5 credits of Directed Research or Undergraduate Research may be used to satisfy the math elective requirement.

Minor in Mathematics

In order to earn a minor in mathematics, students must complete 30 credits in mathematics, including:

MATH 134   **Calculus I**.. **5**
MATH 135   **Calculus II**... **5**
MATH 136   **Calculus III** **5**
Approved mathematics courses (222 or higher) **15**

See policy for minors (84-1) for more information.

Advanced Placement in Calculus

Students who have completed a college-level course in calculus in high school and have taken the advanced placement test in calculus of the College Entrance Examination Board may petition the department for placement on the basis of their test results. Advanced placement and credit may be granted to students whose test scores are 3 or above. Advanced placement may also be obtained through departmental testing.

Proper Sequence for Taking Courses

The normal sequence of elementary mathematics courses is MATH 110; MATH 118 or MATH 120; MATH 130 or MATH 131 or MATH 134. A student who has received a 2.00 or better in any course of this sequence or its equivalent cannot subsequently receive credit for a course that appears before it in the sequence. A student may not receive credit for more than two courses among MATH 107, MATH 110, and MATH 200. A student may not receive credit for more than one course from each of the following groups: MATH 118 and 120; MATH 130, MATH 131, and MATH 134; MATH 244 and MATH 351. A student who has taken MATH 130 or MATH 131 and, due to a change of major, is required to take MATH 134 as preparation for MATH 135 will receive credit for both MATH 130 (or MATH 131) and MATH 134. In these cases credit for MATH 134 will be contingent on completing MATH 135 with a 2.00 or better.

Mathematics Courses

Eligibility to remain in courses for which students are registered will be based on the criteria listed within each course description, and will be determined by the instructor after the first day of class.

MATH 107   **Mathematical Reasoning and Its Applications** **5**
An introduction to mathematical ideas, emphasizing quantitative methods applied to life experiences, with a focus on logical thinking and algorithmic processes. Topics studied: graphing, exponential growth, probability, and statistics. Additional topics may include voting theory, graph theory, geometry, or other mathematical concepts and applications. Credit not granted to a student who has previously received credit for MATH 118 or a higher numbered mathematics course. Core mathematics option. Prerequisite: one year each of high school algebra and geometry. (fall, winter, spring)

MATH 110   **Functions and Algebraic Methods** **5**
Functions including linear, quadratic, other polynomial, and exponential. Modeling applications and problem solving emphasized. Supporting topics include equations, inequalities, systems of equations, rational expressions, exponents and radicals. Graphing calculator required. Core mathematics option. Prerequisite: university mathematics entrance requirements or satisfactory score on the Mathematics Placement Exam. (fall, winter, spring)

MATH 118   **College Algebra for Business** **5**

Functions, graphing; linear, quadratic, exponential, logarithmic functions; systems of linear equations; inequalities; linear programming; applications to business. Graphing calculator required. Credit not granted for both MATH 118 and MATH 120. Core mathematics option. Prerequisite: a grade of C- or better in MATH 110 or satisfactory score on SAT or ACT or Mathematics Placement Exam. (fall, winter, spring)

MATH 120   **Precalculus: Algebra** **5**

A study of functions including polynomial, rational, exponential, and logarithmic functions; composite and inverse functions; theory of polynomial equations; other selected topics. Provides review and extension of basic algebraic methods for solving equations and inequalities. Problem solving and mathematical writing are emphasized as well as algebraic skill. Graphing calculator required. Credit not granted for both MATH 118 and 120. Core mathematics option. Prerequisite: a grade of C- or better in MATH 110, or a satisfactory score on SAT or ACT or the Mathematics Placement Exam. (fall, winter, spring)

MATH 121   **Precalculus: Trigonometry** **2**

Radian measure, trigonometric functions and their graphs, identities, trigonometric equations, inverse trigonometric functions. Graphing calculator required. Prerequisite: a grade of C- or better in MATH 118 or MATH 120, or a satisfactory score on SAT or ACT or the Mathematics Placement Exam. (fall, winter, spring)

MATH 130   **Elements of Calculus for Business** **5**

Limits; continuity; rate of change; derivative, basic differentiation formulas, extrema; area under a curve; the definite integral and applications. Graphing calculator required. Core mathematics option. Prerequisite: a grade of C- or better in MATH 118 or MATH 120, or satisfactory score on SAT or ACT or the Mathematics Placement Exam. (fall, winter, spring)

MATH 131   **Calculus for Life Sciences** **5**

Limits; rate of change; derivatives, basic differentiation formulas, extrema; the definite integral. Applications to the life and social sciences. Graphing calculator required. Core mathematics option. Co-requisite: MATH 121, unless exempted by qualifying examination. Prerequisite: a grade of C- or better in MATH 118 or MATH 120 or satisfactory score on SAT or ACT or the Mathematics Placement Exam. (winter, spring)

MATH 134   **Calculus I** **5**

Limits and derivatives of rational, exponential, and trigonometric functions; applications of limits and derivatives. Computer laboratory component. Graphing calculator required. Core mathematics option. Co-requisite: MATH 121, unless exempted by qualifying examination. Prerequisite: a grade of C- or better in MATH 120, or satisfactory score on SAT or ACT or the Mathematics Placement Exam. (fall, winter, spring)

MATH 135   **Calculus II** **5**

Theory, techniques, and applications of integration; differentiation and integration of trigonometric, exponential, and logarithmic functions; indeterminate forms; improper integrals. Graphing calculator required. Prerequisite: a grade of C- or better in MATH 134. (fall, winter, spring)

MATH 136   **Calculus III** **5**

Infinite series; Taylor's theorem; vectors; polar coordinates; solid analytic geometry. Graphing calculator required. Prerequisite: a grade of C- or better in MATH 135. (fall, winter, spring)

MATH 200   **Mathematics for K-8 Teachers** **5**

Systems of numeration; algorithms; elementary logic; sets; introduction to probability and statistics. Emphasis on logic and problem solving. Prerequisite: MATH 110 or 107 or equivalent. (winter of even years)

MATH 222 **Discrete Structures** **5**

Introduction to methods of proof, based on logic; set theory, quantifiers, mathematical induction, functions; equivalence relations and partitions; algebraic structures, including Boolean algebras; combinatorics; graph theory and other applications to computer science used as context for proof. Prerequisites: a grade of C- or better in MATH 135 or instructor permission; a computer programming course. (fall of even years)

MATH 232 **Multivariable Calculus** **3**

Partial derivatives, multiple integration, and applications. Graphing calculator required. Prerequisite: a grade of C- or better in MATH 136. (fall, winter, spring)

MATH 233 **Linear Algebra** **3**

Matrices, determinants, vector spaces, linear transformations, eigenvalues. Graphing calculator required. Prerequisite: a grade of C- or better in MATH 136. (fall, winter, spring)

MATH 234 **Differential Equations** **4**

First and second order differential equations; linear differential equations; systems of differential equations; power series solutions. Co-requisite or prerequisite: MATH 232. Prerequisite: a grade of C- or better in MATH 233. (fall, winter, spring)

MATH 244 **Probability and Statistics for the Sciences and Engineering** **5**

Probability models; discrete and continuous random variables, basic concepts of descriptive and statistical inference; applications. The course will include use of computer software. Cannot apply both MATH 244 and MATH 351 toward a mathematics major. Prerequisite: a grade of C- or better in MATH 135 or instructor permission. (winter, spring)

MATH 291-293 **Special Topics** .... **1 to 5**

MATH 296 **Directed Study** .... **1 to 5**

MATH 310 **Introduction to Advanced Mathematics** **5**

Logic and proofs; quantifiers; basic notions of set theory; induction, Cartesian products and relations; equivalence relations; functions; cardinality. Prerequisite: a grade of C or better in MATH 136. (spring)

MATH 321 **Euclidean and Modern Geometries** **5**

An axiomatic approach to finite geometries and basic Euclidean geometry; straight-edge and compass constructions; problems of antiquity; special topics in Euclidean geometry. Geometric transformations, the fifth postulate and non-Euclidean geometries. Prerequisite or co-requisite: MATH 310. (spring of odd years)

MATH 331 **Introduction to Complex Variables** **5**

The complex number system; analytic functions including exponential, logarithmic, and trigonometric functions; series; residues. Prerequisite: a grade of C or better in MATH 234. (fall of even years)

MATH 351 **Probability** **5**

Basic concepts and theorems in probability theory; the binomial, Poisson, normal, and other fundamental probability distributions; moments; limit theorems. Cannot apply both MATH 244 and MATH 351 toward a mathematics major. Prerequisite: a grade of C or better in MATH 232. (fall of odd years)

MATH 361 **Applied Mathematics I** **5**

Introduction to numerical methods for solving differential equations, phase plane analysis of nonlinear differential equations. Introduction to modeling. Computer laboratory component. Prerequisite: PHYS 121 and a grade of C or better in MATH 234. (winter of even years)

MATH 371   **Introduction to Numerical Methods** **5**

Approximation and errors; solution of equations and systems of linear equations; numerical integration. Four lecture hours and one computer laboratory hour per week. Prerequisites: a grade of C or better in MATH 233; proficiency in a programming language. (winter of odd years)

MATH 391-393   **Special Topics**... **1 to 5**

MATH 396   **Directed Study** .... **1 to 5**

MATH 411   **Introduction to Abstract Algebra I**.. **5**

MATH 412   **Introduction to Abstract Algebra II**... **5**

Theory of groups, rings, fields, and field extensions; vector spaces and linear transformations; special topics. Prerequisites: for MATH 411, instructor permission granted on first day of class; for MATH 412, a grade of C or better in MATH 411. (offered in sequence: fall of even years, winter of odd years)

MATH 431   **Introduction to Real Analysis I**... **5**

MATH 432   **Introduction to Real Analysis II** **5**

The real number system; continuity; point set theory; partial differentiation; Riemann-Stieltjes integrals; sequences and series of functions; power series; uniform convergence. Prerequisites: for MATH 431, instructor permission granted on first day of class; for MATH 432, a grade of C or better in MATH 431. (offered in sequence: fall of odd years, winter of even years)

MATH 461   **Applied Mathematics II**.. **5**

Introduction to partial differential equations and the boundary value problems of mathematical physics; separation of variables, applications of Fourier series, Fourier transform. Computer laboratory component. Prerequisite: a grade of C or better in both MATH 232 and MATH 361. (spring of even years)

MATH 480-483 Interdisciplinary Core Course .... **3 to 5**

Title and content change each term.

MATH 488   **Senior Synthesis I** **2**

Exploration of mathematical problems and applications. Each student will choose a topic to pursue. Library research. Development of student portfolio. Investigation of relationship between major and Core. Oral and written presentations. Required for all mathematics majors. Prerequisite: permission of instructor granted on first day of class. (fall)

MATH 489   **Senior Synthesis II** **2**

Continued development of synthesis topic and portfolio. Academic self-assessment. Additional mathematical topics including the history of mathematics. Required for all mathematics majors. Prerequisite: MATH 488. (winter)

MATH 490   **Senior Synthesis III** **1**

Presentation of the Senior Synthesis project, including both an oral and written presentation. Required for all mathematics majors. The sequence MATH 488, 489, 490 satisfies the core Senior Synthesis requirement. Prerequisite: MATH 489. (spring)

MATH 491-493   **Special Topics**... **1 to 5**

MATH 496   **Independent Study** .... **1 to 5**

MATH 497   **Directed Reading** .... **1 to 5**

MATH 498   **Directed Research**... **1 to 5**

MATH 499   **Undergraduate Research** .... **1 to 5**

Mathematical investigation of a research problem in collaboration with a faculty advisor culminating in an oral or written presentation. Prerequisite: permission of faculty advisor and of chair.

Mechanical Engineering

Greg S. Mason, PhD, PE, Chair

Objectives

Mechanical Engineering is among the broadest and most versatile of the engineering professions. Mechanical engineering encompasses many diverse activities and fields of interest, including design for environment, machine design, solid mechanics, materials, environmentally conscious energy systems, fluid mechanics, heat transfer, thermodynamics, combustion, control systems, manufacturing, or a combination of these fields as is often the case in the development of complex projects. Mechanical engineers can pursue careers in design, manufacturing, research and development, sales, management, and consulting.

The mission of the Department of Mechanical Engineering is to provide educational opportunities for students seeking to enter the mechanical engineering profession, so that they can achieve competence in the field while recognizing their social responsibilities. The program provides a strong foundation in the areas of mathematics, basic sciences, engineering theory and practice, and the humanities and social sciences. It encourages further self development and life-long intellectual achievement. The program seeks to build student skills in written and oral communication, socially, economically and environmentally responsible decision making, and professionalism.

The following program objectives have been designed to support both the departmental and university missions:

- **Technical Proficiency:** Ability to apply knowledge of mathematics, physics and the principles of engineering appropriate to the students' chosen areas of specialization, to the solution of contemporary problems in mechanical engineering.
- **Communications Skills:** Ability to communicate effectively in written, graphical, and oral formats.
- **Professional Skills:** Mastery of the broad spectrum of abilities needed in professional practice including skills in teamwork, leadership, creativity and project management, and an understanding of professional ethics, business practices, safety, and economics.
- **Personal Breadth:** Appreciation of the non-technical aspects of engineering, including ethical considerations, concern for society and the environment, and multi-cultural perspectives, as well as a commitment to life-long learning and service to the professional and civic communities.

Degree Offered
Bachelor of Science in Mechanical Engineering

Major Offered
Mechanical Engineering

Departmental Requirements

In addition to the prerequisites, departmental candidacy is required for entry into 300- and 400-level courses. Candidacy is achieved by successfully completing all required 100 and 200 level CEEGR, CHEM, MEGR, MATH, and PHYS courses with a combined grade point average of at least 2.50, and completing ENGL 110. Only courses graded C (2.00) or better may be transferred to offset degree requirements. Both the cumulative grade point average and the College of Science and Engineering grade point average must be at least 2.50 for graduation. Before completing the design sequence (MEGR 487/488/489) students

must take a comprehensive exam (for details, refer to the Mechanical Engineering Student Handbook). Taking the Fundamentals of Engineering (FE) examination is required for the degree. This degree is accredited by the Engineering Accreditation Commission of ABET, formerly know as the Accreditation Board for Engineering and Technology.

Bachelor of Science in Mechanical Engineering
Major in Mechanical Engineering

In order to earn the bachelor of science in mechanical engineering degree with a major in mechanical engineering, students must complete a minimum of 180 credits including at least 45 credits in the core curriculum. A cumulative 2.50 grade point average is required, in addition to a science and engineering grade point average of 2.50, including the following:

I. Core Curriculum Requirements

45 credits in the core curriculum, including:

ENGL 110	**College Writing: Inquiry and Argument**	5
PHIL 110	**Introduction to Philosophy and Critical Thinking**	5

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**	
HIST 121	**Studies in Modern Civilization**	

ENGL 120	**Introduction to Literature**	5
PHIL 220	**Philosophy of the Human Person**	5

Social Science I (not economics) 5
Social Science II satisfied by CEEGR 302
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary satisfied within major.
Senior Synthesis filled by MEGR 487, 488, 489.

II. Major Program Requirements

74 credits in mechanical engineering, including:

MEGR 105	**Engineering Graphics and Design**	3
MEGR 106	**Machine Shop**	1
MEGR 181	**Innovative Design**	2
MEGR 210	**Statics**	4
MEGR 230	**Dynamics**	4
MEGR 281	**Engineering Methods**	4
MEGR 304	**Data Acquisition and Instrumentation**	4
MEGR 321	**Thermodynamics**	5
MEGR 324	**Heat Transfer**	5
MEGR 350	**Materials Science**	5
MEGR 371	**Machine Elements**	5
MEGR 435	**Dynamic Systems**	5
MEGR 438	**Control Systems**	4
MEGR 487	**Engineering Design I**	3
MEGR 488	**Engineering Design II**	4
MEGR 489	**Engineering Design III**	3
Engineering Electives (approved by department)		9

Choose one of the following two courses: 4

| MEGR 322 | **Thermodynamics II** |
| MEGR 372 | **Machine Elements II** |

III. Other Major Department Requirements

61 credits in math, science and engineering, including:

CEEGR 221	**Mechanics of Materials I**.. 4
CEEGR 302	**Engineering Economy** 3
CEEGR 331	**Fluid Mechanics** 4
CHEM 121	**General Chemistry I** 4
CHEM 131	**General Chemistry Lab I** 1
ECEGR 315	**Elements of Electrical Engineering** 5
MATH 134	**Calculus I**.. 5
MATH 135	**Calculus II**.. 5
MATH 136	**Calculus III** 5
MATH 232	**Multivariable Calculus** 3
MATH 233	**Linear Algebra**... 3
MATH 234	**Differential Equations**... 4
PHYS 121	**Mechanics** 5
PHYS 122	**Electricity and Magnetism** 5
PHYS 123	**Waves and Optics**.. 5

NOTE: 1. A minimum of 45 credits in core curriculum courses is required for graduation. 2. The Fundamentals of Engineering (FE) examination is required for graduation.

Mechanical Engineering Courses

MEGR 100   Introduction to Mechanical Engineering 1
An overview of mechanical engineering. Course includes seminars by practicing mechanical engineers who discuss day-to-day engineering and the latest advances in the industry. Typical industries represented include: aerospace, transportation, HVAC, power generation, manufacturing, medical equipment, and sports equipment. Graded CR/F. One seminar per week. (spring)

MEGR 105   Engineering Graphics and Design... 3
Technical sketching. Isometric, orthographic, auxiliary, and sectional views. Dimensioning. Introduction to computer-aided drafting (CAD) and solid modeling. Includes design project using CAD. Three two-hour sessions per week. Laboratory. (fall, winter)

MEGR 106   Machine Shop 1
Manufacturing processes including casting, welding, forging, plastics forming and metal cutting. Lab includes industry tours and hands-on machine shop projects focusing on fundamental theory and operation of precision measuring instruments, hand tools, metal lathes and CNC mills. Pre or co-requisite: MEGR 105. Prerequisite: CEEGR 221. (fall, winter, spring)

MEGR 181   Innovative Design.. 2
The design process, including performance prediction and prototype construction and testing. Includes a guided class project, team evaluation of an existing engineering design, and a major team design project. Final exam will consist of an oral presentation and performance demonstration of the team design. Two 70 minute sessions per week. Laboratory. Prerequisite: freshman or sophomore standing. (fall, winter)

MEGR 210 **Statics** **4**
Vector algebra. Equilibrium of forces and moments, distributed forces, hydrostatics, friction, virtual work; all applied to simple bodies. Four lectures per week. Prerequisites: MATH 135, PHYS 121. (fall, winter)

MEGR 230 **Dynamics** **4**
Vectors applied to kinematics and kinetics. Particle, system of particles, and rigid bodies related to translation, rotation, plane motion, relative motion, forces, impulse-momentum, work-energy. Four lectures per week. Prerequisites: MEGR 210. (winter, spring)

MEGR 281 **Engineering Methods** **4**
Modern methods using computers to solve problems encountered in mechanical and civil engineering. Examples are stress analysis and beams (numerical integration, matrix methods, systems of simultaneous equations), stability of mechanical systems and columns (differential equations). Four lectures per week. Co-requisites: MEGR 230, MATH 233. (fall, spring)

MEGR 291-293 **Special Topics** .... **1 to 5**
MEGR 296 **Directed Study** .... **1 to 5**
MEGR 304 **Data Acquisition and Instrumentation** **4**
Introduction to computer based data acquisition, including D to A and A to D conversion, real time operating systems, digital filtering, sensor selection and sensor interface design. Three lectures, one laboratory per week and a final design project. Pre or co-requisite: ECEGR 315. Prerequisite: MEGR 281. (spring)

MEGR 321 **Thermodynamics** **5**
Thermal properties of ideal and real gases, liquids, vapors and mixtures. Conservation of energy. Second law. Conversion of thermal energy to work. Power, efficiency, cycles, air-conditioning, compressible gas flow. Four lectures and one laboratory per week. (fall)

MEGR 322 **Thermodynamics II** **4**
Continuation of MEGR 321. Thermodynamics applied to ideal and real cycles, internal and external combustion engines, fans, blowers, compressors, nozzles, refrigeration, air-conditioning. Second-law analysis. Design problem. Four lectures per week. Prerequisite: MEGR 321. (winter)

MEGR 324 **Heat Transfer** **5**
Heat transfer—conduction, convection and radiation. Conduction in one and two dimensions, steady state and transient. Forced and natural convection with phase change. Radiation between two or three black and gray bodies. Heat exchangers. Design problem. Four lectures and one laboratory per week. Prerequisite: MEGR 321. Pre- or co-requisite: CEEGR 331. (spring)

MEGR 342 **Manufacturing Processes** **3**
Overview of manufacturing processes including casting, forming, machining and welding; physics governing processes, the associated process parameters and their influences. Two lectures and one laboratory or field trip per week. Prerequisite: MEGR 350.

MEGR 350 **Materials Science** **5**
Atomic structure. Metallic bond. Structure of metals and non-metals. Equilibrium diagrams. Time-dependent transformations. Relation of structure to properties. Elastic and plastic deformation. Four lectures and one laboratory per week. (fall)

MEGR 371 **Machine Elements** **5**
Advanced strength of materials including combined loading, beams, columns, connection forces and stress concentrations. Introduction to statics and reliability. Introduction to finite element analysis. Material failure including static failure theories, fracture mechanics and fatigue. Design problem. Four lectures and one laboratory per week. Prerequisite: CEEGR 221. (winter)

MEGR 372   Machine Elements II **4**

Continuation of MEGR 371. Fasteners, welds, springs, bearings, gears, shafts, lubrication, clutches and brakes. Design problem. Four lectures per week. Prerequisite: MEGR 371. (spring)

MEGR 391-393   Special Topics...**1 to 5**

MEGR 396   Directed Study ....**1 to 5**

MEGR 404   Experimental Design... **3**

An introduction to the application of statistics in engineering problems. Topics include point estimates, population inference using p-values and confidence intervals, type 1 and type 2 error estimates, and ANOVA analysis when applied to engineering and manufacturing problems. Applications of statistics include statistical process control, sample size selection and experiment design using a factorial design approach. Three lectures per week. Prerequisite: junior standing.

MEGR 405   Introduction to Finite Elements.. **3**

Development of theory and concepts of finite element analysis. Applications in all areas of mechanical engineering, including mechanics of solids, heat transfer, fluid mechanics and design. Weekly computer exercises. Three lectures per week. Prerequisites: MEGR 371, MEGR 324, and senior standing.

MEGR 422   Energy and Environment.. **3**

Overview and discussion of primary energy consumption and energy conservation techniques. Theory and design of environmentally conscious energy conversion and relevant pollution reduction technologies. Assessment of energy conversion technologies with life-cycle analysis. Design and research projects. Three lectures per week. Prerequisites: MEGR 321 and junior standing.

MEGR 423   Introduction to Combustion **3**

An introduction to the topic of combustion. The areas of study include the thermodynamics of combustion, chemical kinetics and combustion reaction analysis, study of diffusion and premixed flames, combustion related to spark-ignited and diesel engines, and special topics of combustion including pollution reduction, instrumentation for combustion processes, and microscale combustion. Three lectures per week. Prerequisites: MEGR 321 and junior standing.

MEGR 426   Heat/Ventilation/Refrigeration **3**

Psychometrics; space heating and cooling loads; air conditioning; fans and ducts; heat exchangers; solar systems; refrigeration. Three lectures per week. Prerequisites: MEGR 321, MEGR 324.

MEGR 431   Vehicle Dynamics **3**

Application of the principles of engineering mechanics to the dynamics of ground vehicles. Familiarization with methods to analyze, predict and design for vehicle dynamic performance. Acceleration and braking performance, aerodynamics and road loads, ride, directional response, rollover. Three lectures per week. Prerequisite: MEGR 230.

MEGR 432   Mechanical Vibrations.. **3**

Analysis of structural vibrations of mechanical systems. Modeling of lumped and distributed parameter systems. Topics include: single- and multi-degree of freedom systems, free and forced vibrations, periodic and non-periodic forcing functions, mass/stiffness matrices, Lagrange's equations, and modal analysis. Continuous systems (string, rod, and beam vibrations). Design considerations and experimental testing methods. Three lectures per week. Prerequisite: junior standing.

MEGR 435   Dynamic Systems **5**

Modeling of mechanical, thermal, hydraulic, pneumatic, and electrical linear and non-linear systems. Introduction to computer modeling and simulation using existing symbolic computer programs. Laplace transforms, stability criteria, and frequency response. Four lectures and one laboratory per week. Prerequisite: ECEGR 315 and MEGR 281; Pre- or co-requisite: MEGR 324. (fall)

MEGR 438   **Control Systems**.. **4**

Feedback control system analysis. Proportional, integral and derivative control. Control system design, compensation. Root locus, Nyquist and Bode plots. Analog and digital simulation. Four lectures per week. Prerequisite: MEGR 435. (winter)

MEGR 451   **Mechanics of Composite Materials** **3**

Introduction, basic concepts, fabrication methods, stress and strain analysis of fiber-reinforced composite materials. Elastic behavior of unidirectional lamina, lamination theory, effects of temperature and moisture, stress and failure analysis of laminates, composite structural design, and experimental characterization. Three lectures per week. Prerequisite: junior standing.

MEGR 471   **Kinematics and Dynamics of Machinery**.................................... **3**

Analysis and synthesis of mechanisms based on combinations of linkages and cams. Considers geometry of motion, velocity and acceleration profiles, and associated forces. Uses manual analytical and graphical methods as well as more advanced computer methods. Three lectures per week. Prerequisite: MEGR 230.

MEGR 487   **Engineering Design I**.. **3**

MEGR 488   **Engineering Design II**... **4**

MEGR 489   **Engineering Design III** **3**

Group design project focusing on the integrative aspects of engineering subject matter. The project focuses on: (1) philosophy of design, a creative approach, and a comprehensive design project; planning, organizing and leading an engineering project; exercising judgment and considering economic factors; and (2) integrated aspects of creative design and analysis; case studies; design of a novel device or system. Format consists of classroom lectures and individual design team meetings each week. The three courses must be taken as a continuous sequence. Fulfills the senior synthesis core requirement. Prerequisite: department permission. (487 fall; 488 winter; 489 spring)

MEGR 491-493   **Special Topics**.. **1 to 5**

MEGR 496   **Independent Study** .... **1 to 5**

MEGR 497   **Directed Reading** .... **1 to 5**

MEGR 498   **Directed Research**... **1 to 5**

MEGR 499   **Undergraduate Research** .... **1 to 5**

Analytical, numerical, or laboratory investigation of a research problem in mechanical engineering under the supervision of a mechanical engineering department faculty member. Graded CR/F. Prerequisite: junior standing.

Physics

David Boness, PhD, Chair

Objectives

The Physics Department offers two degree programs, the bachelor of science (BS) and the bachelor of arts (BA). There are two versions of the BA program: the bachelor of arts with a major in physics, and the bachelor of arts with a major in physics and with a specialization in humanities for teaching (BAHT program).

For those who wish a career in physics, the bachelor of science in physics program takes the student from classical mechanics through quantum mechanics, including advanced laboratory work emphasizing modern physics. The curriculum is designed to prepare students for advanced work in pure and applied physics in graduate school or in industry, but the degree is also excellent preparation for careers in engineering or computer programming, or for admission to medical, dental, law, or business school. Graduates with the BS degree in physics work in industry, federally funded national laboratories, academic institutions, or other places where a strong problem solving background is valued.

The bachelor of arts program is ideal for those who desire a solid background in physics but who also want the flexibility to pursue other interests. Students planning to go on to teach at the high school level can enter teacher certification and master degree programs in education regardless of which physics degree is earned, but the BAHT program is specially designed for physics majors seeking a career in high school teaching. Note that the BAHT program does not by itself give state teacher certification; further work is needed.

Degrees Offered
Bachelor of Arts
Bachelor of Science in Physics

Majors Offered
Physics
Physics with specialization in Humanities for Teaching

Minor Offered
Physics

Bachelor of Arts
Major in Physics

In order to earn the bachelor of arts degree with a major in physics, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110	**College Writing: Inquiry and Argument** 5	
PHIL 110	**Introduction to Philosophy and Critical Thinking** 5	

Choose one of the following two courses: 5

HIST 120	**Origins of Western Civilization**
HIST 121	**Studies in Modern Civilization**

ENGL 120   Introduction to Literature... 5
Fine Arts (one approved 5 credit course; see course descriptions).. 5
PHIL 220   Philosophy of the Human Person... 5
Social Science I   5
Social Science II (different discipline from Social Science I)... 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division).. 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   .... 3 to 5
Senior Synthesis   3

II. Major Requirements

45 credits in physics, including:

PHYS 121   Mechanics 5
PHYS 122   Electricity and Magnetism 5
PHYS 123   Waves and Optics.. 5
PHYS 204   Relativity... 2
PHYS 205   Introduction to Quantum Physics 3
PHYS 206   Modern Physics Laboratory 3
PHYS 230   Computing Tools for Physical Science... 3
PHYS 250   Mathematical Methods for Physics 4
PHYS 310   Classical Mechanics 5
PHYS 330   Electromagnetic Field Theory 5
PHYS   Electives (300 level or above).. 5

III. Other Major Department Requirements

MATH 134   Calculus I... 5
MATH 135   Calculus II.. 5
MATH 136   Calculus III 5
MATH 232   Multivariable Calculus 3
MATH 233   Linear Algebra... 3
MATH 234   Differential Equations.. 4
Related science electives (approved by department) 15

NOTE: No physics courses numbered 120 or below may be counted toward the major.

Bachelor of Arts
Major in Physics
Specialization in Humanities for Teaching

In order to earn the bachelor of arts degree with a major in physics and with a specialization in humanities for teaching, students must complete a minimum of 180 credits with a cumulative grade point average of 2.50, and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

HUMT 150   Composition: Language and Thought... 5
HUMT 151   Composition: Language and the Arts 5
HUMT 152   Logic, Ethics, and Discernment 5
HUMT 161   Humanities: Introduction to Tutoring 2
HUMT 162   Humanities: Introduction to Tutoring 1

HUMT 163	**Humanities: Introduction to Tutoring** 1
HUMT 171	**Proseminar: Humanistic Foundations of Education** 5
HUMT 180	**Socio-Cultural Transformations I**.. 5
HUMT 181	**Socio-Cultural Transformations II** 5
HUMT 182	**Socio-Cultural Transformations III** 5
HUMT 273	**Seminar on Secondary Education** 5
HUMT 274	**Supervised Internship in Secondary Education** 5
HUMT 301	**Perspectives on the Person I**... 5
HUMT 302	**Perspectives on the Person II**.. 5
HUMT 371	**Education and the Polity**.. 5
HUMT 372	**Leadership and Teaching**... 5
HUMT 380	**Cultural Interface**... 5
HUMT 400	**Seminar on Contemporary Problems**... 5
HUMT 471	**Jesuit Education**.. 5
HUMT 472	**Jesuit Education Practicum** 5
CISS 120	**Poverty in America**... 5

II. Major Requirements

48 credits in physics, including:

PHYS 121	**Mechanics** 5
PHYS 122	**Electricity and Magnetism** 5
PHYS 123	**Waves and Optics**.. 5
PHYS 204	**Relativity**.. 2
PHYS 205	**Introduction to Quantum Physics** 3
PHYS 206	**Modern Physics Laboratory** 3
PHYS 230	**Computing Tools for Physical Science**... 3
PHYS 250	**Mathematical Methods for Physics** 4
PHYS 310	**Classical Mechanics** 5
PHYS 330	**Electromagnetic Field Theory** 5
PHYS 487	**Senior Synthesis**.. 3
PHYS	**Electives (300 level or above)**... 5

III. Other Major Department Requirements

MATH 134	**Calculus I**... 5
MATH 135	**Calculus II**.. 5
MATH 136	**Calculus III** 5
MATH 232	**Multivariable Calculus** 3
MATH 233	**Linear Algebra**... 3
MATH 234	**Differential Equations**... 4
CHEM 121	**General Chemistry I** 4
CHEM 131	**General Chemistry Lab I** 1
CHEM 260	**Laboratory Safety** 2
Related Science Electives (approved by department).. **8**

NOTE: For a secondary endorsement in general science, 5 credits of earth science and 5 credits of BIOL 161/171 will satisfy science electives. For a detailed description of this degree see the introductory pages for the College of Science and Engineering. Students interested in teaching should contact the Master in Teaching program (206) 296-5759 or visit the website *seattleu.edu/coe/mit.*

Bachelor of Science in Physics

In order to earn the bachelor of science in physics degree, students must complete a minimum of 180 credits with a cumulative and major/department grade point average of 2.00, including the following:

I. Core Curriculum Requirements

ENGL 110   **College Writing: Inquiry and Argument** 5
PHIL 110   **Introduction to Philosophy and Critical Thinking** 5

Choose one of the following two courses: 5
HIST 120   **Origins of Western Civilization**
HIST 121   **Studies in Modern Civilization**

ENGL 120   **Introduction to Literature** 5
Fine Arts (one approved 5 credit course; see course descriptions) 5
PHIL 220   **Philosophy of the Human Person** 5
Social Science I   5
Social Science II (different discipline from Social Science I) 5
Theology and Religious Studies Phase II (200-299) 5
Ethics (upper division) 5
Theology and Religious Studies Phase III (300-399) 5
Interdisciplinary   .... 3 to 5
Senior Synthesis   3

II. Major Requirements

65 credits in physics, including:

PHYS 121   **Mechanics** 5
PHYS 122   **Electricity and Magnetism** 5
PHYS 123   **Waves and Optics** 5
PHYS 203   **Thermodynamics** 3
PHYS 204   **Relativity** 2
PHYS 205   **Introduction to Quantum Physics** 3
PHYS 206   **Modern Physics Laboratory** 3
PHYS 230   **Computing Tools for Physical Science** 3
PHYS 250   **Mathematical Methods for Physics** 4
PHYS 310   **Classical Mechanics** 5
PHYS 330   **Electromagnetic Field Theory** 5
PHYS 370   **Advanced Physics Laboratory** 4
PHYS 385   **Quantum Mechanics** 5
PHYS 410   **Advanced Classical Physics** 5
PHYS   **Electives (300 level or above)** 8

III. Other Major Department Requirements ....

MATH 134   **Calculus I** 5
MATH 135   **Calculus II** 5
MATH 136   **Calculus III** 5
MATH 232   **Multivariable Calculus** 3
MATH 233   **Linear Algebra** 3
MATH 234   **Differential Equations** 4
Related Science Electives (approved by department) 5

NOTE: No physics courses numbered 120 or below may be counted toward the major.

Minor in Physics

In order to earn a minor in physics, students must complete 30 credits in physics, including:

PHYS 121   **Mechanics** 5
PHYS 122   **Electricity and Magnetism** 5
PHYS 123   **Waves and Optics** 5
PHYS 205   **Introduction to Quantum Physics** 3
PHYS   **Electives (200-level and above)** 12

NOTE: No physics courses numbered 120 or below may be counted toward the minor.

See Policy for minors (84-1) for more information.

Physics Courses

NOTE: 1. PHYS 101, PHYS 102, PHYS 104, PHYS 105, PHYS 106, PHYS 107, PHYS 121, PHYS 122, and PHYS 123 combine lectures and discussion with laboratory sessions. Any of these satisfies the core Phase One laboratory science requirement. 2. Credit may be received for only one of the following series: PHYS 105/106/107 or PHYS 121/122/123.

PHYS 100   From Quarks to the Cosmos 2
A non-mathematical introduction to some of the most interesting aspects of contemporary physics. Topics include the nature of space and time, the fundamental constituents of matter, and the evolution of the universe from the big bang to the present epoch of accelerated expansion. Evaluation in the course is based on class participation, essay exams, and a term paper. Grading is CR/F. There are no prerequisites. (fall)

PHYS 101   Astronomy: The Solar System 5
An introduction to astronomy for non-science students that satisfies the Core laboratory science requirement. Topics considered include a description of the motions of celestial objects as seen from earth; explanation of the motions from the early Greeks through the moderns; a survey of the physical properties and origins of the solar system, including the latest findings of space probes. The course may include an astrobiology emphasis. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 102   Astronomy: Stars, Galaxies, and Cosmology 5
An introduction to astronomy for non-science students that satisfies the Core laboratory science requirement. Topics include light and telescopes; the distance, motion, and brightness of stars; the birth and death of stars; black holes; normal and abnormal galaxies; the big bang, the expanding universe, curved spacetime, and the fate of the universe. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 104   Science as a Human Process 5
How science is actually done by real people; history of physics; concepts of relativity and quantum physics and their effect on society; additional topics may include recent controversies in science, such as global warming, ozone depletion, or what caused the death of the dinosaurs. Course includes laboratory component. Prerequisite: core mathematics or placement in MATH 120 or higher.

PHYS 105   Mechanics 5
A non-calculus survey of classical mechanics. Topics covered include kinematics in one and two dimensions; dynamics, Newton's laws and gravitation; work and energy; momentum, rotational motion, and equilibrium. Course includes laboratory component. Prerequisites: MATH 120, 121, or equivalent.

PHYS 106   Waves, Sound, Electricity and Magnetism **5**

Continuation of the non-calculus survey of introductory physics. Topics covered include fluids; simple harmonic motion; mechanical waves and sound; electric charge, field, and potential; electric energy and capacitance; electric current and resistance; magnetic fields and electromagnetic induction. Course includes laboratory component. Prerequisite: PHYS 105. (winter)

PHYS 107   Thermodynamics, Optics, and Modern Physics **5**

Completion of the non-calculus survey of introductory physics. Topics treated include temperature and kinetic theory; heat and the laws of thermodynamics; ray and wave optics; introduction to the ideas of quantum mechanics; radioactivity and radiation. Course includes laboratory component. Prerequisite: PHYS 106. (spring)

PHYS 121   Mechanics **5**

An introduction to calculus-based physics for students of science and engineering. Topics treated include vectors; kinematics; force and Newton's laws; work, energy, and power; conservation of momentum and collisions; rotational dynamics and rigid body motion; gravitation. Course includes laboratory component. Prerequisite or co-requisite: MATH 135. (winter, spring)

PHYS 122   Electricity and Magnetism **5**

Continuation of calculus-based physics for students of science and engineering. Topics covered include electric charge, forces, field, flux; Gauss' law; electric potential; conductors, dielectrics, capacitance; current, resistance, and DC circuits; magnetic forces and fields; Ampere's law; Faraday's law and inductance; Maxwell's equations. Course includes laboratory component. Prerequisites: PHYS 121, MATH 135. (fall, spring)

PHYS 123   Waves and Optics **5**

Completion of the calculus-based survey of physics for students of science and engineering. Topics covered include harmonic motion; mechanical, and electromagnetic waves; electromagnetic properties of materials; reflection, refraction, dispersion, interference, diffraction, and polarization of waves. Course includes laboratory component. Prerequisites: PHYS 122, MATH 136. (fall, winter)

PHYS 203   Thermodynamics **3**

An introduction to thermodynamics for students of science and engineering. Topics treated include temperature, work, heat, and internal energy; reversible processes; entropy and its interpretations; thermodynamic equilibrium; the laws of thermodynamics; ideal gases; kinetic theory and distributions; heat engines and refrigerators; phase transitions; application to physical systems. Prerequisites: PHYS 122, MATH 136. (winter)

PHYS 204   Relativity **2**

An introduction to special relativity for students of science and engineering. Topics covered include the Lorentz transformation and its consequences; relativistic kinematics; relativistic dynamics, collisions, and conservation laws. Prerequisite: PHYS 123. (spring)

PHYS 205   Introduction to Quantum Physics **3**

An introduction to quantum mechanics for students of science and engineering. Topics covered include evidence for the quantization of light, matter, and energy; the wave nature of matter; the Bohr model of the atom; wave-particle duality; the uncertainty principle; the Schrödinger equation and its applications; the Pauli exclusion principle and the periodic table of the elements. Prerequisites: PHYS 123, MATH 232. (spring)

PHYS 206　　　　　**Modern Physics Laboratory** **3**

A rigorous introduction to experimental physics through modern physics laboratory investigations. Emphasis is on experimental method, including experimental design, proper use of laboratory notebooks and record keeping, data acquisition, data analysis and interpretation, measurement statistics and uncertainty, quantitative support of conclusions, and presentation and dissemination of results. Physics topics for investigation emphasize 20th century physics. Prerequisite or co-requisite: PHYS 205. (spring)

PHYS 230　　　　　**Computing Tools for Physical Science**... **3**

An introduction to scientific computer programming for students of science and engineering. Emphasis is on numerical and symbolic computation methods with applications in the physical sciences. Instruction in the use of programming languages or packages such as MATLAB, Fortran 95, and Mathematica are given at an elementary level. Elementary programming skills required for doing scientific computation, such as numerical evaluation and plots of functions, statistical analysis and plots of data, numerical computations and symbolic calculations are emphasized. Prerequisite: PHYS 122. (winter)

PHYS 250　　　　　**Mathematical Methods for Physics** **4**

A course to facilitate the understanding and use of mathematics in the physical sciences. Topics include applications of vector calculus; Fourier analysis; applications of differential equations; coordinate systems; special functions. Prerequisites: PHYS 123, MATH 234. (fall)

PHYS 291-293　　　**Special Topics**.. **1 to 5**

PHYS 296　　　　　**Directed Study** .... **1 to 5**

PHYS 310　　　　　**Classical Mechanics** **5**

Newtonian mechanics for students of physics. Topics include point-particle mechanics in 3-dimensions; oscillations; Newton's theory of gravitation; central force motion; dynamics of systems of particles; Lagrangian and Hamiltonian dynamics; dynamics of rigid bodies. Prerequisites: PHYS 230 or equivalent, PHYS 250. (winter)

PHYS 330　　　　　**Electromagnetic Field Theory** **5**

The theory of electromagnetism using vector calculus for students of physics and electrical engineering. Topics covered include static electric and magnetic fields in vacuum and linear isotropic media; time-varying fields and Maxwell's equations; the wave equation and boundary conditions; propagation of electromagnetic waves in non-conducting media. Prerequisites: PHYS 123, MATH 234. (fall)

PHYS 340　　　　　**Nonlinear Dynamical Systems and Chaos**.. **4**

An introduction to nonlinear dynamical systems. Topics include coupled linear and nonlinear difference equations; coupled linear and nonlinear ordinary differential equations; fixed points; equilibrium points; stability; bifurcations; limit cycles; logistic equation; Feigenbaum scaling; fractals; Hausdorff dimension; dissipative and Hamiltonian systems; Liapunov's method; strange attractors; nonlinear oscillations; perturbation theory; Lorenz equations; chaos; predictability; computer programming and graphics. Prerequisites: PHYS 123, PHYS 230 or equivalent, MATH 234. (winter)

PHYS 362　　　　　**Introduction to Astrophysics**.. **4**

An introduction to the physics of stars and galaxies. Topics include observational properties of stars; equations of stellar structure; physics of stellar interiors; birth, evolution, and death of stars; globular clusters; galaxies. Prerequisites: PHYS 203, PHYS 230 or equivalent, PHYS 250.

PHYS 363　　　　　**Introduction to Geophysics** **4**

An introduction to physics of the earth. Topics include earth formation; plate tectonics; geomagnetism; continuum mechanics; earthquakes and seismology; physical properties of the deep earth; high-pressure geophysics. Prerequisites: PHYS 203, PHYS 230 or equivalent, PHYS 250.

PHYS 370   **Advanced Physics Laboratory** **4**

Experimental physics laboratory to introduce students to the work of a professional experimental physicist. Students will design and execute a few experiments in depth in such areas as chaotic dynamical systems, laser diode spectroscopy, nuclear magnetic resonance, sonoluminescence, plasma physics, superconductivity, and nuclear physics, and will learn state-of-the-art computer-based data acquisition techniques, such as LabView. Students will present a talk in the style of a professional physics conference and prepare a paper in the style of a professional physics research journal. Prerequisites: PHYS 205, 206, MATH 234. (winter of alternate years)

PHYS 385   **Quantum Mechanics** **5**

A mathematical treatment of quantum mechanics using complex vector spaces, operators, wave functions, and abstract Dirac notation. Topics treated include wave-particle duality, the state function, the Schrödinger equation, one-dimensional problems, the operator formalism, matrices, central forces, angular momentum, spin, identical particles. Prerequisites: PHYS 205, 310. (spring)

PHYS 391-393   **Special Topics** .... **1 to 5**

PHYS 396   **Directed Study** .... **1 to 5**

PHYS 410   **Advanced Classical Physics** **5**

A course in advanced classical physics, emphasizing continuous matter and fields. Topics may include these: normal modes of finite and continuous systems; Laplace's and Poisson's equations; the heat/diffusion equation; the wave equation; equations of continuity; and Euler's and the Navier-Stokes equation. Prerequisites: PHYS 310, 330. (fall)

PHYS 430   **Modern Optics for Physicists and Engineers** **4**

Introduction to modern optics consisting of ray optics; scalar wave optics; diffraction; interferometry; vector wave optics and polarization; Gaussian beam optics; Fourier optics, including image processing, spatial filtering, and holography; optical waveguides and fibers; optical resonators; laser amplifiers and systems; semiconductor lasers and detectors; optical switching and computing. Optional labs in holography and fiber optics. Prerequisites: PHYS 330.

PHYS 450   **Atomic Physics** **4**

Introduction to modern atomic physics. Topics may include: single electron without spin in central potential, radiative transitions, spin and the fine structure of the hydrogen spectrum, two electron systems, independent electron approximation, shells, electronic configurations, spectroscopic notation, interaction with external fields, hyperfine structure, isotope shifts, optical and radiofrequency spectroscopy, atomic beam methods, measurement of atomic lifetimes and oscillator strengths, electronic and atomic collisions. Prerequisites: PHYS 330, 385.

PHYS 470   **Solid-State Physics** **4**

An introduction to the physics of solids for physics students. Topics covered include symmetry; crystal structure; x-ray and neutron diffraction; types of solids and bonding; vibrations in solids—phonons; electronic band structure; metals and semiconductors; p-n junctions. Prerequisite: PHYS 385.

PHYS 480-483   **Interdisciplinary Core Courses** .... **3 to 5**

Title and content change each term these courses are offered.

PHYS 481   **Origins: Cosmology and Culture** **5**

A study of the origin and evolution of the universe and the cultural and historical influences that have shaped our understanding of the cosmos. Satisfies the core interdisciplinary requirement. Does not count for physics elective credit. Prerequisite: junior standing.

PHYS 486   **Particle and Nuclear Physics** **5**
An introduction to the physics of nuclei and elementary particles for physics students. Topics covered include an historical introduction to the elementary particles; symmetries and conservation laws; quantum electrodynamics; the weak interaction; introduction to quantum chromodynamics; properties of nuclei; nuclear radiations and their detection; nuclear structure and nuclear models. Prerequisites: PHYS 330, 385.

PHYS 487   **Senior Synthesis** **3**
Capstone course integrating physics and the humanities through investigation of one or more themes. Readings, classroom discussion, essays, and student presentations. Satisfies core senior synthesis requirement. Does not count for physics elective credit. Prerequisite: permission of chair.

PHYS 491-493   **Special Topics** .... **1 to 5**
PHYS 496   **Independent Study** .... **1 to 5**
PHYS 497   **Directed Reading** .... **1 to 5**
PHYS 498   **Directed Research** .... **1 to 5**
PHYS 499   **Undergraduate Research** .... **1 to 6**
Literature search and laboratory or computer investigation of a research problem in physics under the supervision of a faculty member. Prerequisite: permission of department chair.

Premedical and Predental

Margaret L. Hudson, PhD, Advisor

If you are interested in careers in medicine, dentistry, veterinary medicine, optometry, physical therapy, pharmacy, or biomedical research, please meet with Dr. Hudson early during your first year at Seattle University, and after that on a regular basis, so that we can work together toward your professional goals. It is important also to meet regularly with your academic advisor in your major department. You will probably want to get involved in the PreHealth Club, which sponsors speakers, outings, and projects of interest to students preparing for careers in the health professions. The PreHealth Handbook, available online through the Seattle University website, should be helpful at all stages of your planning and exploration of careers in the health professions.

Most of Seattle University's premedical, predental, preveterinary, preoptometry, and other pre-health professions students major in biology, chemistry, biochemistry, physics, general science, or psychology, but you may choose any academic major at Seattle University as long as you complete at least the minimum science course work listed below. Within the framework of any one of these undergraduate degree programs, students obtain strong backgrounds in the liberal arts through the core curriculum.

Most medical, dental, and veterinary schools typically require the following undergraduate science sequences: CHEM 121, 122, 123, 131, 132, 133, 335, 336, 337, 345, 346, 347; BIOL 161/171, 162/172, 163/173; PHYS 105, 106, 107 or PHYS 121, 122, 123. Schools of optometry generally require less organic chemistry. Professional schools also recommend or require calculus, cell physiology, and biochemistry. Check the Bulletins of the professional schools of interest to you and talk with Dr. Hudson to learn about specific requirements. Most professional schools require, as a part of the application process, nationally standardized exams that draw on your college science background and analytical skills. These exams are taken a year to a year and a half in advance of the time you expect to enroll in the professional school, so planning the timing of required science courses is important.

Competition for entrance into medical, dental, veterinary, optometry, and other health professions schools is strong. The schools look for evidence of intellectual ability, understanding of the profession based on your own direct experience, a sense of service, and personal qualities appropriate to the profession. Since required academic course work is challenging and professional demands are high, it is important that you regularly assess whether your original goal is still right for you.

The application process for entering graduate programs or professional school should start at least a year in advance of the time you hope to enroll. Dr. Hudson and your academic advisor will be happy to assist you. The required standardized tests such as the Medical College Admissions Test (MCAT), Optometry Admission Test (OAT), Graduate Record Exam (GRE) and the Dental Admission Test (DAT) are administered individually on computer by appointment with a testing service. The health professions schools to which you are applying will ask you to provide to them transcripts and individual letters of recommendation from people who are able to speak directly about your strengths.

The Premedical/Predental Advisory Committee is available to conduct an interview with each applicant and subsequently will write a supportive letter of evaluation for each qualified applicant. Interviews with the Committee are scheduled with Dr. Hudson and are held in May.

Post-baccalaureate Pre-professional Health Studies Certificate Program

Margaret Hudson, PhD, Advisor

Objectives

This program is focused on assisting individuals who have not already taken the science courses required for admission by health professions schools, and who may benefit by advice and assistance in preparation for a career in the health professions. Those interested in medicine, dentistry, veterinary medicine, physical therapy, optometry, and physician assisting have participated successfully in the post-baccalaureate program at Seattle University.

Admission

The post-baccalaureate premedical certificate program is open to applicants with at least a bachelor's degree from a regionally accredited program. Applicants will need to complete an application form and provide transcripts of all college level course work and degrees. Because our program is kept small, to gain admission, applicants must clearly communicate their intentions, motivation, and plans through the application process. Applications must be received by March 1 to be considered for entrance the following fall quarter. Applicants are expected to have a GPA of at least 3.00 in the last two years of their degree work plus any post-baccalaureate course work taken prior to enrollment at Seattle University or permission of the chief premedical/predental advisor.

Program

Students in the program are advised by the program director, take classes along with our undergraduate students, and interview with our Premedical/Predental Advisory Committee in preparation for their interviews at professional schools. Both individual faculty members and the Committee write letters of recommendation for post-baccalaureate students, to be sent to the professional schools of their choice. Post-baccalaureate students are also welcome to participate in the Seattle University PreHealth Club and so can take part in service activities, field trips, and a mock MCAT exam, as well as meetings with health care professionals, with other students in the process of applying to professional schools, and with admissions officers from health professions schools. The program advisor offers advice about career exploration, about individual professional schools, about strategy and practice for professional school interviews, and provides feedback on the personal statement and other essays for application to professional school.

Certificate of Post-baccalaureate Studies Pre-professional Health Studies

In order to earn the certificate, a student must complete a minimum of 30 credits in the courses listed below at Seattle University with a minimum cumulative grade point average of 3.00.

Requirements

BIOL 161	**Biology I: Molecular and Cellular Biology**	4
BIOL 171	**Biology I Lab**	1
BIOL 162	**Biology II: Evolution and Ecology**	4
BIOL 172	**Biology II Lab**	1
BIOL 163	**Biology III: Physiology and Development**	4

BIOL 173	**Biology III Lab**	**1**
CHEM 121	**General Chemistry I**	**4**
CHEM 131	**General Chemistry Lab I**	**1**
CHEM 122	**General Chemistry II**	**4**
CHEM 132	**General Chemistry Lab II**	**1**
CHEM 123	**General Chemistry III**	**4**
CHEM 133	**General Chemistry Lab III**	**1**

Choose option a. or b. in consultation with an advisor and based on intended course of post-graduate studies:...12 to 16

a. CHEM 231   **Fundamental Organic Chemistry I (4)**
   CHEM 241   **Fundamental Organic Chemistry Lab I (2)**
   CHEM 232   **Fundamental Organic Chemistry II (4)**
   CHEM 242   **Fundamental Organic Chemistry Lab II (2)**
b. CHEM 335   **Organic Chemistry I (3)**
   CHEM 345   **Organic Chemistry Lab I (2)**
   CHEM 336   **Organic Chemistry II (3)**
   CHEM 346   **Organic Chemistry Lab II (2)**
   CHEM 337   **Organic Chemistry III (4)**
   CHEM 347   **Organic Chemistry Lab III (2)**

Choose option a or b:...15

a. PHYS 105   **Mechanics**
   PHYS 106   **Waves, Sound, Electricity and Magnetism**
   PHYS 107   **Thermodynamics, Optics, and Modern Physics**
b. PHYS 121   **Mechanics**
   PHYS 122   **Electricity and Magnetism**
   PHYS 123   **Waves and Optics**