Drexel University
Catalog 2007 / 2008

Table of Contents

The College of Engineering Undergraduate Programs

Drexel University

Catalog 2007 / 2008

The College of Engineering

Since its founding in the midst of the industrial revolution in 1891, Drexel University has emphasized its strengths in engineering, science and technology to train men and women to become leaders. In little over a century, Drexel University has transformed itself into a large, comprehensive institution committed to excellence in education, research and service to the engineering society and to the broader community. Although much has changed, the original mission of the university still rings true today.

The profession of engineering is concerned with turning the natural elements and energies to the service of mankind. The objectives of the undergraduate program in the College of Engineering are:

- *To offer an education that will give graduates the flexibility to adjust to future changes in technology*
- *To develop a sense of professionalism*
- *To provide a framework for concentrated study in a professional area*

To implement those objectives the curricula of the College of Engineering are designed to provide a firm grounding in basic science and liberal arts, along with broad-based engineering sciences and professional engineering subjects.

The College of Engineering

Degree Requirements
The degree of Bachelor of Science in the engineering specialties requires a minimum of 192 credits of academic work and six terms of co-op or engineering experience. Transfer students must complete a minimum of four terms of industrial/ engineering experience in order to earn a co-operative engineering degree accredited by the Accreditation Board for Engineering and Technology (ABET). All full-time students in the college of engineering are required to complete the minimum four terms of co-op experience.

Engineering students must maintain an overall grade point average of 2.0 in all required courses in their major.

Curricular Organization
With the exception of Computer Science majors, all students in the College of Engineering study the same subjects during the three terms in the first year. During the two terms of the sophomore year, students begin taking department specific coursework.

The first five terms are devoted to those subjects that form the foundation of the engineering curriculum. Courses in the core engineering curriculum are organized and taught to provide an integrated view of the basic sciences and an introduction to the art of engineering through group projects that deal with open-ended problems characteristic of the practice of engineering. Students also learn to use the modern tools of engineering both on the computer and in the laboratory.

The college considers it essential that students entering the Drexel Engineering Curriculum be placed in courses that take advantage of their abilities and prior training. Student preparation level is determined by a review committee that evaluates the student's high school record, standardized test scores, and placement tests administered during freshman orientation.

Students who demonstrate the preparation and skills to succeed in our integrated engineering calculus course immediately will be placed in MATH 121/MATH 122 starting in the fall term. Students who are not prepared for this sequence may participate in a special "pre-engineering" program before the fall term. These students may also have a modified fall schedule and may need summer school during the following summer.

In the second year, two professional subjects are introduced, and all the first-level professional courses are completed by the junior year. The senior year in all curricula contains at least one elective sequence so that students can study some aspect of engineering more deeply. In addition, all curricula provide a design experience in the senior year. Recognizing the importance of liberal studies in the

education of an engineer, all curricula require that courses be taken in this area. These requirements are described under the Liberal Studies Program section.

Mission Statement

The mission of the Drexel Engineering Curriculum is to research, develop, implement, and share educational programs that integrate the foundations of engineering practice, humanities and communications, mathematics, and sciences.

Program Objectives

- *Provide students with a foundation for applying principles of science and mathematics to their disciplinary programs.*
- *Provide students with the skills and technical knowledge to perform engineering design.*
- *Provide students with skills to communicate technical ideas and present persuasive arguments.*
- *Provide students with teamwork skills.*
- *Provide students with understanding of what engineers do through personal experience.*

The Common First Year

Humanities and other courses		Credits
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
UNIV 101	**The Drexel Experience (two semesters)**	2.0

Foundation requirements		
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0
PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory II**	1.0
ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ENGR 201	**Evaluation/Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation/Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0

ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0

Liberal Studies Program

The Liberal Studies Program is designed to give engineering students a foundation in the following areas: English, history of the engineering profession and its impact on modern society, ethical standards required for the practice of the profession, and an in-depth study in a specific discipline in liberal studies.

All engineering majors must take 10 courses. Three of the 10 courses are designated as follows and must be completed by all majors:

Designated liberal studies course requirements

ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0

The remaining liberal studies course requirements are undesignated and can be chosen from the disciplines listed below. Any course selected from the categories below meets this requirement, except language courses below 200 level and survey, performance, studio, or skills courses. Two of the five courses must comprise a sequence and therefore must be in the same discipline, but not necessarily sequentially numbered.

- Anthropology
- Architectural/Social History
- Art History
- Communications
- Dance
- Dramatic Writing
- Film and Video
- History
- Language (200 level and above)
- Literature
- Music
- Philosophy
- Political Science
- Psychology
- Sociology
- Theater

Architectural engineering students' liberal studies requirements are slightly different. The three-course ARCH 141–ARCH 143 (Architecture and Society) sequence, offered through the Antoinette Westphal College of Media Arts and Design, is required of all architectural engineering students, and fulfills the two-course sequence requirement.

Some engineering majors require a study in basic economic principles. Check curriculum guidelines for requirements. Any required economics courses will replace liberal studies requirements on a course-for-course basis.

Electives
In addition to the electives in the Liberal Studies Program there are two types of elective sequences in the engineering curricula: technical electives and free electives.Technical electives are courses in engineering, science, or management that build on the required professional courses and lead to a specific technical specialization. Possible elective sequences should be discussed with and approved by advisors before the end of the junior year.Free electives are any courses for which students are eligible and that are not remedial in nature for engineering students.

Withdrawal from the College of Engineering
It is the policy of the College of Engineering that an engineering student who withdraws from the University cannot petition for readmission to the College of Engineering until at least one complete term has elapsed.

Writing-Intensive Course Requirements
In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog indicates that this course can fulfill a writing-intensive requirement. Departments will designate specific sections of such courses as writing-intensive. Sections of writing-intensive courses are not indicated in this catalog. Students should check the section comments in Banner when registering. Students scheduling their courses in Banner can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term. For more information on writing-intensive courses, see the Drexel University Writing Program's Writing-Intensive Course page.

The College of Engineering

Accelerated Programs/ Bachelor's/Master's Dual Degree Program
The Accelerated Program of the College of Engineering provides opportunities for highly talented and strongly motivated students to progress toward their educational goals essentially at their own pace. Primarily through advanced placement, credit by examination, flexibility of scheduling, and independent study, the program makes it possible to complete the undergraduate curriculum and initiate graduate study in less than the five years required by the standard curriculum. Students enrolled in this program may take advantage of the five-year Bachelor's/Master's Dual Degree Program described on the College of Engineering's Accelerated: B.S./M.S. web page.

Lincoln University/Drexel 3-3 Plan
Drexel participates in a program with Lincoln University under which a student may attend Lincoln University for three years, taking liberal arts subjects and pre-engineering courses in mathematics, science, and related areas; transfer to Drexel; and receive a degree in engineering after three additional years at Drexel. This is similar to the conventional 3-2 program in which other colleges and universities participate; the extra year is necessitated by Drexel's co-operative education plan.

Indiana University of Pennsylvania/Drexel Plan
Indiana University of Pennsylvania and Drexel University have established a co-operative engineering program to increase the opportunities for young men and women from rural Pennsylvania to pursue careers in engineering. The program combines two years of study at the state-owned university with three years of study as part of the Drexel Plan of Co-operative Education.

Pre-Professional Programs
The College of Engineering offers Master of Science programs in engineering management and software engineering, and master's and Ph.D. programs in chemical engineering, civil engineering, electrical engineering, materials engineering, and mechanical engineering. An Advanced Certificate in Engineering is also offered. For additional information, consult the graduate catalog or contact the graduate division of the College of Engineering.

Students wishing to prepare for admission to professional schools of law or medicine may obtain preprofessional counseling and assistance in making application from the Office of Preprofessional Programs, 215-895-2437.

Architectural Engineering

The architectural engineering major prepares graduates for professional work in the analysis, design, construction, and operation of residential, commercial, institutional, and industrial buildings. The program develops engineers familiar with all aspects of safe and economical construction. Students study the principles of structural support and external cladding, building environmental systems, and project management and develop depth in at least one area.

The program integrates building disciplines, including coordination with architects; construction managers; civil, mechanical, and electrical engineers; and others. Students use computer-aided design tools to understand system interactions; perform analysis, design, scheduling, and cost analysis; and present their work.

The first two years of the curriculum cover fundamentals necessary for all engineers. The pre-junior and junior years emphasize building systems and the principles governing their performance. In addition to the core engineering and science, students learn architectural approaches through studio design. Seniors focus on either structural or building environmental systems design, as well as a full-year realistic design project. The academic program is complemented by exposure to professional practice in the co-op experience.

Mission Statement

The civil and architectural engineering faculty are responsible for delivering an outstanding curriculum that equips our graduates with the broad technical knowledge, design proficiency, professionalism, and communications skills required for them to make substantial contributions to society and to enjoy rewarding careers.

Program Objectives

Architectural engineering graduates will become professionals who analyze, design, construct, manage, or operate residential, commercial, institutional and industrial buildings and systems, or advance knowledge of the field.

Senior Design Projects

A special feature of the major is senior design. A group of students works with a faculty advisor to develop a significant design project selected by the group. All architectural engineering students participate in a design project.

For more information about this major, contact the Department of Civil, Architectural and Environmental Engineering.

Architectural Engineering

Bachelor of Science Degree: 193.0 credits

Required courses

General education requirements		23.0 Credits
ENGL 101	Expository Writing and Reading	3.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGL 103	Analytical Writing and Reading	3.0
UNIV 101	The Drexel Experience	2.0
	Liberal studies electives	12.0

Foundation requirements		65.5 Credits
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 200	Multivariate Calculus	4.0
PHYS 101	Fundamentals of Physics I	4.0
PHYS 102	Fundamentals of Physics II	4.0
PHYS 201	Fundamentals of Physics III	4.0
CHEM 101	General Chemistry I	3.5
CHEM 102	General Chemistry II	4.5
BIO 141	Essential Biology	4.5
CS 121	Computational Laboratory I	1.0
CS 122	Computational Laboratory II	1.0
CS 123	Computational Laboratory II	1.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
ENGR 102	Engineering Design Laboratory II	2.0
ENGR 103	Engineering Design Laboratory III	2.0
ENGR 201	Evaluation/Presentation of Experimental Data I	3.0
ENGR 202	Evaluation/Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
ENGR 232	Dynamic Engineering Systems	3.0

Major requirements		75.5 Credits
AE 220	Introduction to HVAC	3.5
AE 340	Architectural Illumination and Electrical Systems	3.0
AE 390	Architectural Engineering Design I	4.0
AE 391	Architectural Engineering Design II	4.0
AE 544	Building Envelope	4.0
ARCH 141	Architecture and Society I	3.0
ARCH 142 WI	Architecture and Society II	3.0
ARCH 143 WI	Architecture and Society III	3.0
ARCH 191	Studio I	3.0
ARCH 192	Studio 2	3.0
CAE 491 WI	Senior Project Design I	3.0
CAE 492 WI	Senior Project Design II	3.0
CAE 493 WI	Senior Project Design III	3.0
CAEE 201	Introduction to Infrastructure Engineering	3.0
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	3.0
CIVE 240 WI	Engineering Economics	3.0
CIVE 250	Construction Materials	4.0
CIVE 330	Hydraulics	3.0
CIVE 320	Fundamentals of Fluid Flow	3.0
MEM 202	Engineering Mechanics: Statics	3.0
MEM 230	Mechanics of Materials I	4.0
ENGR 361	Statistical Analysis of Engineering Systems	4.0

Students select one of the following concentrations:

Mechanical concentration requirements		29.0 Credits
AE 430	Control Systems for HVAC	3.0
CIVE 370	Introduction to Structural Analysis	3.0
CIVE 371	Structural Design	3.0
CIVE 372	Structural Laboratory	1.0
MEM 345	Heat Transfer	4.0
MEM 413	Air Conditioning and Refrigeration I	3.0
MEM 414	Air Conditioning and Refrigeration II	3.0
	Three professional electives	9.0

Structural concentration requirements		29.0 Credits
CIVE 300	Theory of Structures I	3.0
CIVE 301	Theory of Structures II	4.0

CIVE 310	**Soil Mechanics**	4.0
CIVE 400	**Structural Design I**	3.0
CIVE 401	**Structural Design II**	3.0
CIVE 402	**Structural Design III**	3.0
CIVE 410	**Foundational Engineering**	3.0
	Two professional electives	6.0

Writing-Intensive Course Requirements

In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

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Drexel University
Catalog 2007 / 2008

Recommended Plan Of Study

BS Architectural Engineering

5 YR UG Co-op Concentration /Mechanical Engineering

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
ARCH 191	Studio 1-1	3.0
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MEM 202	Engineering Mechanics-Statics	3.0
	Term Credits	*18.0*

Term 6		Credits
AE 340	Architectural Illumination and Electrical Systems	3.0
ARCH 141	Architecture and Society I	3.0

ARCH 192	Studio 1-2	3.0
CIVE 320	Fundamentals of Fluid Flow	4.0
MEM 230	Mechanics of Materials I	4.0
	Term Credits	*17.0*

Term 7		Credits
AE 220	Introduction to HVAC	3.5
ARCH 142	Architecture and Society II	3.0
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	4.0
CIVE 250	Construction Materials	4.0
CIVE 330	Hydraulics	3.0
	Term Credits	*17.5*

Term 8		Credits
AE 390	Architecture Engineering Design I	4.0
ARCH 143	Architecture and Society III	3.0
CIVE 240	Engineering Economic Analysis	3.0
CIVE 370	Introduction to Structural Analysis	3.0
MEM 345	Heat Transfer	4.0
	Term Credits	*17.0*

Term 9		Credits
AE 391	Architecture Engineering Design II	4.0
CIVE 371	Introduction to Structural Design	3.0
CIVE 372	Structural Laboratory	1.0
	Liberal studies elective	3.0
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*14.0*

Term 10		Credits
AE 544	Building Envelope Systems	3.0
CAE 491	Senior Design Project I	3.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
MEM 413	HVAC Loads	3.0
	Liberal studies elective	3.0
	Term Credits	*15.0*

Term 11		Credits
CAE 492	Senior Design Project II	3.0
MEM 414	HVAC Equipment	3.0
	Liberal studies elective	3.0
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*12.0*

Term 12		Credits
AE 430	Control Systems for HVAC	3.0
CAE 493	Senior Design Project III	3.0
	Liberal studies elective	3.0
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*12.0*

	Total Credits (minimum)	193.0

Drexel University
Catalog 2007 / 2008

Recommended Plan Of Study

BS Architectural Engineering
5 YR UG Co-op Concentration /Structural

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
ARCH 191	Studio 1-1	3.0
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MEM 202	Engineering Mechanics-Statics	3.0
	Term Credits	*18.0*

Term 6		Credits
AE 340	Architectural Illumination and Electrical Systems	3.0
ARCH 141	Architecture and Society I	3.0

ARCH 192	Studio 1-2	3.0
CIVE 320	Fundamentals of Fluid Flow	4.0
MEM 230	Mechanics of Materials I	4.0
	Term Credits	*17.0*

Term 7		Credits
AE 220	Introduction to HVAC	3.5
ARCH 142	Architecture and Society II	3.0
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	4.0
CIVE 250	Construction Materials	4.0
CIVE 330	Hydraulics	3.0
	Term Credits	*17.5*

Term 8		Credits
AE 390	Architectural Engineering Design I	4.0
ARCH 143	Architecture and Society III	3.0
CIVE 240	Engineering Economic Analysis	3.0
CIVE 300	Theory of Structures I	3.0
CIVE 310	Soil Mechanics I	4.0
	Term Credits	*17.0*

Term 9		Credits
AE 391	Architectural Engineering Design II	4.0
CIVE 301	Theory of Structures II	4.0
	Liberal studies elective	3.0
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*14.0*

Term 10		Credits
AE 544	Building Envelope Systems	3.0
CAE 491	Senior Design Project I	3.0
CIVE 400	Structural Design I	3.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
	Liberal studies elective	3.0
	Term Credits	*15.0*

Term 11		Credits
CAE 492	Senior Design Project II	3.0
CIVE 401	Structural Design II	3.0
CIVE 410	Foundation Engineering	3.0
	Liberal studies elective	3.0
	Term Credits	*12.0*

Term 12		Credits
CAE 493	Senior Design Project III	3.0
CIVE 402	Structural Design III	3.0
	Liberal studies elective	3.0
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*12.0*

	Total Credits (minimum)	193.0

Minor in Architectural Engineering

The minor in architectural engineering, designed to broaden the professional capabilities of students, offers the building systems portion of the architectural engineering curriculum with enough attention to structural components for completeness. Pursuing a minor in architectural engineering can be of interest to mechanical engineering students who wish to learn the application of HVAC systems within the building context; to civil engineering students who require knowledge of large-scale infrastructure systems; and to chemical engineering students who wish to understand the energy and distribution aspects of process plant design.

While this minor is primarily designed to provide technical knowledge and skills to other engineers, with the appropriate prerequisites students from other disciplines—such as architecture—can also complete this minor.

The minor consists of a minimum of 24 credits total, with five required core courses. Students take a minimum of eight additional credits taken from a list of optional courses.

Prerequisites

The common engineering core curriculum prerequisites are required of all students in the College of Engineering. Students from other colleges will need the appropriate background prerequisite courses in physics, mathematics and thermodynamics.

Required courses		**16.5 Credits**
CAEE 201	**Introduction to Infrastructure Engineering**	3.0
AE 220	**Introduction to HVAC**	3.5
AE 340	**Architectural Illumination and Electrical Systems**	3.0
or		
ARCH 263	**Environmental Systems III**	3.0
AE 390	**Architectural Engineering Design I**	4.0
CIVE 370	**Introduction to Structural Analysis**	3.0

		8.0 Credits
Students select a minimum of eight additional credits from the following:		
CIVE 250	**Construction Materials**	4.0
CIVE 371	**Introduction to Structural Design**	3.0
MEM 413	**Refrigeration and Air Conditioning I**	3.0
MEM 310	**Thermodynamic Analysis I**	4.0
ARCH 14I	**Architecture and Society I**	3.0

ARCH 191	**Studio 1-1**	3.0
or		
ARCH 101	**Studio 1-A**	4.5
AE 391	**Architectural Engineering Design II**	4.0
CIVE 240	**Engineering Economics**	3.0

Chemical Engineering

Chemical engineers are concerned primarily with process engineering, the conversion of raw materials into valuable products. The products can include pharmaceuticals, specialized plastics, petrochemicals, materials for biomedical applications, and energy. The processes, which usually start out at a small laboratory scale, must be developed for production at a large chemical plant scale. The large change in scale requires careful engineering to minimize environmental contamination and to insure public safety.

The Department of Chemical and Biological Engineering is responsible for equipping our graduates with the broad technical knowledge and teamwork skills required for them to make substantial contributions to society.

Program Objectives:
The Chemical Engineering major has four goals for its students:

- Provide students with a strong foundation of scientific principles, teamwork methods, and communication skills for the identification and solution of chemical engineering problems.
- Instill in our students the capacity for self and group-study and experience self-assessment so that they possess the attributes necessary to continue life-long learning.
- Apply elements of public health and safety, concern for the environment, and ethics in the course of studies.
- Familiarize our students with research methodologies.

To help students reach these goals, the curriculum is structured so that they progress through sequences in the fundamental physical sciences, humanities, engineering sciences, and design.

Since chemical engineers have the responsibility for translating the results of chemical research into products for the marketplace, and for preventing the wastes generated by industry from contaminating the environment, the physical sciences sequence includes a strong emphasis on chemistry, with courses in analytical, inorganic, organic, and physical chemistry. All the courses emphasize modern theories of chemistry and are designed to help students gain a clearer understanding of their eventual assignments in engineering science and design.

As students progress to courses in engineering science and design, problems of a textbook nature give way to real-world examples. By senior year, students are involved in comprehensive design projects.

Senior Design Projects

A special feature of the major is senior design. A student — or group of students — works with a faculty advisor to develop a significant design project. Some recent examples include:

- Design of a process to make petrochemical intermediates
- Plastics recycling design
- Process design for antibiotic products

Chemical Engineering

Bachelor of Science Degree: 192.0 credits

Required courses

General education requirements		Credits
HIST 285	Technology in Historical Perspective	3.0
ENGL 101	Expository Writing and Reading	3.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGL 103	Analytical Writing and Reading	3.0
PHIL 315	Engineering Ethics	3.0
UNIV 101	The Drexel Experience	2.0
	Liberal studies electives	15.0
	Free electives	3.0

Foundation requirements		Credits
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 200	Multivariate Calculus	4.0
PHYS 101	Fundamentals of Physics I	4.0
PHYS 102	Fundamentals of Physics II	4.0
PHYS 201	Fundamentals of Physics III	4.0
CHEM 101	General Chemistry I	3.5
CHEM 102	General Chemistry II	4.5
BIO 141	Essential Biology	4.5
CS 121	Computational Laboratory I	1.0
CS 122	Computational Laboratory II	1.0
CS 123	Computational Laboratory III	1.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
ENGR 102	Engineering Design Laboratory II	2.0
ENGR 103	Engineering Design Laboratory III	2.0
ENGR 201	Evaluation/Presentation of Experimental Data I	3.0
ENGR 202	Evaluation/Presentation of Experimental Data II	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0

ENGR 232	**Dynamic Engineering Systems**	3.0

Sophomore engineering elective options (Students select one)

BIO 214	**Principles of Cell Biology**	3.0
CHEM 230	**Quantitative Analysis**	3.0
ENVR 260	**Environmental Science and Society I**	3.0
MATH 221	**Discrete Mathematics**	3.0
PHYS 202	**Fundamentals of Physics IV**	4.0

Professional requirements		**Credits**
CHE 201	**Process Material Balances**	3.0
CHE 202	**Process Energy Balances**	3.0
CHE 206	**Basic Chemical Engineering Thermodynamics**	3.0
CHE 301 WI	**Process Thermodynamics**	3.0
CHE 302	**Process Fluid Mechanics**	4.0
CHE 303	**Process Heat Transfer**	3.0
CHE 304	**Process Mass Transfer**	4.0
CHE 305	**Process Separations**	4.0
CHE 307	**Process Modeling I**	4.0
CHE 308	**Process Modeling II**	4.0
CHE 332 WI	**Chemical Engineering Laboratory I**	2.0
CHE 333 WI	**Chemical Engineering Laboratory II**	2.0
CHE 334 WI	**Chemical Engineering Laboratory III**	2.0
CHE 335	**Statistics and Design of Experiments**	3.0
CHE 420	**Process Systems Engineering**	3.0
CHE 424	**Chemical Kinetics and Reactor Design**	4.0
CHE 481 WI	**Process Design I**	3.0
CHE 482 WI	**Process Design II**	3.0
CHE 483 WI	**Process Design III**	3.0
CHEC 352	**Physical Chemistry and Applications II**	4.0
CHEC 353	**Physical Chemistry and Applications III**	4.0
CHEM 241	**Organic Chemistry I**	4.0
CHEM 242	**Organic Chemistry II**	4.0
CHEM 356	**Physical Chemistry Laboratory I**	2.0
	Concentration electives	14.0

Writing-Intensive Course Requirements
In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog indicates that this course can fulfill a writing-intensive requirement. Departments will designate specific sections of such courses as writing-intensive. Sections of writing-intensive courses are not indicated in this catalog. Students should check the section comments in Banner when registering. Students scheduling their courses in Banner can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term. For more information on writing-intensive courses, see the Drexel University Writing Program's Writing-Intensive Course page.

Graduate-Level Electives

		Credits
CHE 502	**Mathematical Methods in Chemical Engineering**	3.0
CHE 513	**Chemical Engineering Thermodynamics**	3.0
CHE 525	**Transport Phenomena I**	3.0
CHE 543	**Kinetics and Catalysis I**	3.0
CHE 554	**Process Systems Engineering**	3.0
CHE 562	**Bioreactor Engineering**	3.0
CHE 564	**Unit Operations in Bioprocess Systems**	3.0

Drexel University
Catalog 2007 / 2008

Recommended Plan Of Study

BS Chemical Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
CHE 201	Process Material Balances	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
CHE 202	Process Energy Balances	3.0
CHE 206	Basic Chemical Engineering Thermodynamics	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 232	Dynamic Engineering Systems	3.0
	Sophomore engineering elective (See degree requirements for list of options)	3.0
	Term Credits	*15.0*

Term 6		Credits
CHE 301	Process Thermodynamics	3.0
CHE 307	Process Modeling I	4.0
CHEM 241	Organic Chemistry I	4.0

CHEM 356	Physical Chemistry Lab	2.0
HIST 285	Technology in Historical Perspective	3.0
	Term Credits	*16.0*

Term 7		Credits
CHE 302	Process Fluid Mechanics	4.0
CHE 332	Chemical Engineering Laboratory	2.0
CHE 335	Statistics and Design of Experiments	3.0
CHEM 242	Organic Chemistry II	4.0
PHIL 315	Engineering Ethics	3.0
	Term Credits	*16.0*

Term 8		Credits
CHE 303	Process Heat Transfer	3.0
CHE 305	Process Separations	4.0
CHE 333	Chemical Engineering Laboratory II	2.0
CHEC 352	Physical Chemistry and Applications II	4.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 9		Credits
CHE 304	Process Mass Transfer	4.0
CHE 308	Process Modeling II	4.0
CHE 334	Chemical Engineering Laboratory III	2.0
CHEC 353	Physical Chemistry and Applications III	4.0
	Liberal studies elective	3.0
	Term Credits	*17.0*

Term 10		Credits
CHE 420	Process Systems Engineering	3.0
CHE 424	Chemical Kinetics and Reactor Design	4.0
CHE 481	Process Design I	3.0
	Free elective	3.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 11		Credits
CHE 482	Process Design II	3.0
	CHE concentration electives	7.0
	Liberal studies elective	3.0
	Term Credits	*13.0*

Term 12		Credits
CHE 483	Process Design III	3.0
	CHE concentration electives	7.0
	Liberal studies elective	3.0
	Term Credits	*13.0*

	Total Credits (minimum)	192.5

Civil Engineering

Civil engineers are active in the planning, design, construction, research and development, operation, maintenance, and rehabilitation of large engineering systems. A particular focus is the reconstruction of the nation's infrastructure through solutions that minimize the disruption of social and natural environments.

Civil engineering graduates are grounded in the fundamental principles necessary for the practice of this profession in any of its modern branches, including construction management, water resources engineering, structural engineering, geotechnical engineering, transportation engineering, and environmental engineering.

Seven of the required courses in the discipline include integral laboratories or field projects for both educational illustration and professional practice exposure.

Careful selection of the electives specified in the curriculum can lead to a wide variety of career objectives. For instance, students with an interest in water resources engineering may elect advanced courses in hydrology, ecology, and chemistry; select senior professional electives in the geotechnical and water resources areas; and choose appropriate topics for senior design and senior seminar. Seniors, with the approval of the department head, can elect certain graduate courses.

Mission Statement

The civil and architectural engineering faculty are responsible for delivering an outstanding curriculum that equips our graduates with the broad technical knowledge, design proficiency, professionalism, and communications skills required for them to make substantial contributions to society and to enjoy rewarding careers.

Program Objectives

Civil engineering graduates will become professionals who analyze, design, construct, manage or operate physical infrastructure and systems, or advance knowledge of the field.

Senior Design Projects

A special feature of the major is senior design. A group of students works with a faculty advisor to develop a significant design project selected by the group. All civil engineering students participate in a design project.

For more information about this major, contact the Department of Civil, Architectural and Environmental Engineering.

Civil Engineering

Bachelor of Science Degree: 190.5 credits

General education requirements		Credits
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
UNIV 101	**The Drexel Experience**	2.0
	Liberal studies electives	21.0
	Free electives	6.0

Foundation requirements		
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0
PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0
ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ENGR 201	**Evaluation/Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation/Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0
ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0
ENGR 361	**Statistical Analysis of Engineering Systems**	3.0

Major requirements

CAE 491 WI	**Senior Project Design I**	3.0
CAE 492 WI	**Senior Project Design II**	3.0
CAE 493 WI	**Senior Project Design III**	3.0
CAEE 201	**Introduction to Infrastructure Engineering**	3.0
CAEE 210	**Measurements in Civil, Architectural and Environmental Engineering I**	3.0
CAEE 211	**Measurements in Civil, Architectural and Environmental Engineering II**	4.0
CIVE 240	**Engineering Economics**	3.0
CIVE 250	**Construction Materials**	4.0
CIVE 310	**Soil Mechanics I**	4.0
CIVE 320	**Fundamentals of Fluid Flow**	3.0
CIVE 330	**Hydraulics I**	4.0
CIVE 375	**In Situ Material Behavior**	3.0
CIVE 410	**Foundation Engineering**	3.0
CIVE 430	**Hydrology**	3.0
CIVE 477 WI	**Seminar I**	2.0
CIVE 478	**Seminar II**	1.0
ENVE 300	**Introduction to Environmental Engineering**	3.0
MEM 202	**Engineering Mechanics: Statics**	3.0
MEM 230	**Mechanics of Materials I**	4.0
	Senior professional electives*	18.0

*A sequence of three courses in a major area of study is required, with a total of six 3-credit professional electives.

Students select one of the following:

CIVE 370	**Introduction to Structural Analysis**	3.0
or		
CIVE 300	**Theory of Structures I**	3.0

Based on whether or not students are pursuing a structural or non-structural concentration, students select either:

CIVE 301	**Introduction to Structural Analysis II**	4.0
or		
CIVE 371	**Introduction to Structural Design**	3.0
and		
CIVE 372	**Structural Laboratory**	1.0

Recommended Plan Of Study

BS Civil Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MEM 202	Engineering Mechanics-Statics	3.0
	Term Credits	*15.0*

Term 6		Credits
CIVE 240	Engineering Economic Analysis	3.0
CIVE 320	Fundamentals of Fluid Flow	3.0
ENVE 300	Introduction to Environmental Engineering	3.0

MEM 230	Mechanics of Materials I	4.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 7		Credits
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	4.0
CIVE 250	Construction Materials	4.0
CIVE 330	Hydraulics	4.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
	Liberal studies elective	3.0
	Term Credits	*18.0*

Term 8		Credits
CIVE 310	Soil Mechanics I	4.0
CIVE 430	Hydrology	3.0
CIVE 300	Theory of Structures I	3.0
or		
CIVE 370	Introduction to Structural Analysis	3.0
	Liberal studies elective	3.0
	Term Credits	*13.0*

Term 9		Credits
CIVE 375	Structural Material Behavior	3.0
CIVE 410	Foundation Engineering	3.0
	CIVE 301 Theory of Structures II (Non-structural concentration takes CIVE 371 & 372)	4.0
	Liberal studies electives	3.0
	Term Credits	*13.0*

Term 10		Credits
CAE 491	Senior Design Project I	3.0
CIVE 477	Seminar	2.0
	Liberal studies elective	3.0
	Professional electives (See degree requirements for list)	6.0
	Term Credits	*14.0*

Term 11		Credits
CAE 492	Senior Design Project II	3.0
CIVE 478	Seminar	1.0
	Free elective	3.0
	Liberal studies elective	3.0
	Professional electives (See degree requirements for list)	6.0
	Term Credits	*16.0*

Term 12		Credits
CAE 493	Senior Design Project III	3.0
	Free elective	3.0
	Liberal studies elective	3.0
	Professional electives (See degree requirements for list)	6.0
	Term Credits	*15.0*

	Total Credits (minimum)	190.5

Computer Engineering

Computer engineers design smaller, faster, and more reliable computers and digital systems; embed microprocessors in larger systems (e.g. anti-lock brake systems); work in theoretical issues in computing; use object-oriented programming languages; and design large-scale software systems and computer networks. Computer engineers may work in positions that apply computers in control systems, digital signal processing, telecommunications, and power systems, and may design very large-scale integration (VLSI) integrated circuits and systems.

The computer engineering degree program is designed to provide our students with breadth in engineering, the sciences, mathematics, and the humanities, as well as depth in both software and hardware disciplines appropriate for a computer engineer. It embodies the philosophy and style of the Drexel Engineering Curriculum, and will develop the student's design and analytical skills. In combination with the co-op experience, it opens to the student opportunities in engineering practice, advanced training in engineering or in other professions, and an entry to business and administration.

The computer engineering program's courses in ECE are supplemented with five courses from the departments of Mathematics and Computer Science: Programming I and II, Discrete Mathematics, Data Structures, and Software Engineering. Students gain the depth of knowledge of computer hardware and software essential for the computer engineer.

Mission Statement

The ECE Department prepares men and women to become leaders working in a highly dynamic and global environment at the forefront of engineering and pursues research to advance the state-of-the-art in electrical and computer engineering and engineering education.

Program Objectives

Our alumni will:

- *Continue as valued, dependable, and competent employees in a wide variety of fields and industries, in particular as computer engineers,*
- *Succeed in graduate and professional studies, such as engineering, science, law, medicine, and business, if pursued,*
- *Understand the need for life-long learning and continued professional development for a successful and rewarding career,*
- *Accept responsibility for leadership roles, in their profession, in their*

communities, and in the global society, and

- *Function as responsible members of society with an awareness of the social and ethical ramifications of their work.*

Computer Engineering

Bachelor of Science Degree: 192.0 credits

Degree Requirements

Required courses

General education requirements		Credits
ECON 201	**Economics I**	4.0
HIST 285	**Technology in Historical Perspective**	3.0
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
PHIL 315	**Engineering Ethics**	3.0
UNIV 101	**The Drexel Experience**	2.0
	Liberal studies electives	12.0

Foundation requirements		Credits
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0
PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0
ECE 200	**Digital Logic Design**	3.0
ECE 201	**Foundations of Electric Circuits**	3.0
ECE 203	**Programming for Engineers**	3.0
ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0

ENGR 103	**Engineering Design Laboratory III**	2.0
ENGR 201	**Evaluation/Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation/Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0
ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0

Professional requirements		**Credits**
CS 171	**Computer Programming I**	3.0
CS 172	**Computer Programming II**	3.0
CS 260	**Data Structures**	3.0
CS 451	**Software Engineering**	3.0
ECE 491	**Senior Project Design I**	2.0
ECE 492	**SeniorProject Design II**	2.0
ECE 493	**Senior Project Design III**	4.0
ECEC 302	**Digital System Projects**	4.0
ECEC 304	**Design with Microcontrollers**	4.0
ECEC 352	**Secure Computing**	4.0
ECEC 355	**Computer Structures**	4.0
ECEL 301	**ECE Laboratory I**	2.0
ECEL 302	**ECE Laboratory II**	2.0
ECEL303	**ECE Laboratory III**	2.0
ECEL 304	**ECE Laboratory IV**	2.0
ECES 302	**Transform Methods and Filtering**	4.0
ENGR 361	**Statistical Analysis of Engineering Systems**	3.0
MATH 221	**Discrete Mathematics**	3.0
MATH 291	**Complex and Vector Analysis for Engineers**	3.0
	Computer engineering senior sequence	9.0-12.0
	ECE technical electives	9.0-12.0
	Free electives	5.0-11.0

Writing-Intensive Course Requirements

In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

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Drexel University
Catalog 2007 / 2008

Recommended Plan Of Study

BS Computer Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
ECE 200	Digital Logic Design	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MATH 221	Discrete Mathematics	3.0

CS 171	Computer Programming I	3.0
ECEC 302	Digital System Projects	4.0
ECEL 301	ECE Laboratory I	2.0
HIST 285	Technology in Historical Perspective	3.0

MATH 290	Linear Modeling for Engineers	4.0
	Term Credits	*16.0*

Term 7		Credits
CS 172	Computer Programming II	3.0
ECEC 304	Design with Microcontrollers	4.0
ECEL 302	ECE Laboratory II	2.0
ECES 302	Transform Methods and Filtering	4.0
PHIL 315	Engineering Ethics	3.0
	Free elective	3.0

ECEC 355	Computer Structures	4.0
ECEL 303	ECE Laboratory III	2.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
	Liberal studies elective	3.0
	Term Credits	*12.0*

Term 9		Credits
CS 260	Data Structures	3.0
ECEC 352	Secure Computing	4.0
ECEL 304	ECE Laboratory IV	2.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Liberal studies elective	3.0
	Term Credits	*15.0-16.0*

Term 10		Credits
CS 451	Software Engineering	3.0
ECE 491	Senior Design I	2.0
ECEC 411	Computer Hardware	3.0
or		
ECEC 431	Introduction to Computer Networks	3.0
or		
ECEC 451	Computer Arithmetic	3.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Liberal studies elective	3.0
	Term Credits	*14.0-15.0*

Term 11		Credits
MATE 492	Senior Design II	2.0
ECEC 421	Introduction to Operating Systems I	3.0
or		
ECEC 432	Internet Architecture and Protocols	3.0
or		
ECEC 457	Security in Computing	3.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Free elective	3.0
	Liberal studies elective	3.0
	Term Credits	*14.0-15.0*

Term 12		Credits
ECE 493	Senior Design III	4.0
ECEC 422	Introduction to Operating Systems II	3.0
or		
ECEC 433	Network Programming	3.0
or		
ECEC 459	Testing of Hardware	3.0
	ECE Technical elective (300 or 400-level ECE course)	3.0
	Free elective	4.0
	Liberal studies elective	3.0
	Term Credits	*17.0*

	Total Credits (minimum)	192.5-195.5

Minor in Computer Engineering

The Computer Engineering minor is designed to provide students from other computer-intensive majors—such as computer science or other engineering majors—with a foundation of knowledge in the hardware portion of computer systems. The minor consists of a minimum of seven ECE courses resulting in 25 credits. There are four required courses and an additional 12 credits of elective courses.

Prerequisites
The minor assumes that students will have a background in mathematics, physics, and computer programming equivalent to that covered in the first two years of engineering. Programming experience must include CS 171 at the minimum. CS 172 and CS 260 are also recommended, and are required for some upper level Computer Engineering (ECEC) courses. Courses taken to meet these requirements will not count toward the minor.

Required courses		**13.0 Credits**
ECE 200	**Digital Logic Design**	3.0
ECEC 302	**Digital System Projects**	4.0
ECEC 355	**Computer Structures**	4.0
ECEL 304	**ECE Laboratory IV (prerequisite waived for minor)**	2.0

Electives **12.0 Credits**
Students should choose an additional 12 credits from 300- and/or 400-level Computer Engineering (ECEC) courses. All prerequisites must be satisfied.

The Computer Engineering Minor for Electrical Engineering Students
The University limit on the overlap between major and minor programs is 9 credits. Since 5 of the 13 required credits in the Computer Engineering minor are also in the Electrical Engineering degree program, electrical engineering students can overlap one additional 4-credit ECEC course in their major plan of study. ECEC courses that are used to satisfy core or technical electives in the EE degree program, beyond this one additional course, cannot be used toward the Computer Engineering minor due to the credit overlap limit.

Computer Science

The program of study in computer science is designed to prepare students for careers in a rapidly changing profession and to allow easy entrance to graduate education in the field. In addition to the courses in the major, the Bachelor of Science program emphasizes foundation courses in the sciences and in applied mathematics, leading to careers involving applications in science and engineering. The Bachelor of Arts degree emphasizes foundation courses in the humanities and the social sciences, leading to careers involving applications in those areas.

Core courses in both programs include programming and data structures, programming language concepts, computer systems architecture, and a track of courses in software methodology and engineering. Students also choose two other tracks from the following: artificial intelligence, computer graphics, computer and network security, data structures and algorithms, numerical and scientific computation, operating systems, programming languages, and human-computer interaction. Please contact the department for a current list of computer science elective and track courses.

The B. S. program is accredited by the Computing Accreditation Commission (CAC) of the Accreditation Board of Engineering and Technology (ABET).

Mission Statement
To educate students for computer science careers in industry and research with an emphasis on analysis of problems, understanding of fundamental concepts, and interest in lifelong learning. To integrate real-world experiences, e.g., as obtained through the cooperative education program, into the academic curriculum.

Computer Science Program Outcomes:
The Bachelor of Science in Computer Science program prepares its graduates:

- to understand and be able to apply the underlying principles of Computer Science to a variety of problem domains;
- to develop good communication skills so that they can solve problems and communicate their solution;
- to develop strong analytical skills so that they can quickly assess how to solve problems;
- to be able to work in groups and appreciate the dynamic and collaborative nature of problem solving;
- to be equipped with a thorough understanding of the development process of software including design, implementation, documentation, and testing;
- to appreciate the role that computers play in society and to be able to direct the use of technology in a beneficial way and to solve new problems.
- to understand and be able to apply mathematics and science.

The Bachelor of Arts in Computer Science program prepares its graduates:

- to understand and be able to apply the underlying principles of Computer Science to a variety of problem domains;
- to develop good communication skills so that they can solve problems and communicate their solution;
- to develop strong analytical skills so that they can quickly assess how to solve problems;
- to be able to work in groups and appreciate the dynamic and collaborative nature of problem solving;
- to be equipped with a thorough understanding of the development process of software including design, implementation, documentation, and testing;
- to appreciate the role that computers play in society and to be able to direct the use of technology in a beneficial way and to solve new problems.
- to have a broad education in the liberal arts balanced with technical study in computer science.

Computer Science Program Educational Objectives
Drexel Computer Science alumni will:

- be valued employees in a wide variety of occupations in industry, government and academia, in particular as computer scientists and software engineers;
- succeed in graduate and professional studies, such as engineering, science, law, medicine and business;
- pursue life-long learning and professional development to remain current in an ever changing technological world;
- provide leadership in their profession, in their communities, and society;
- function as responsible members of society with an awareness of the social and ethical ramifications of their work.

For more information about this major, contact the Department of Computer Science.

Computer Science

Bachelor of Arts Degree: 186.5 credits

Degree Requirements

General education requirements		55.0 Credits
COM 230	Techniques of Speaking	3.0
ENGL 101	Expository Writing and Reading	3.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGL 103	Analytical Writing and Reading	3.0
PHIL 311	Computer Ethics	3.0
UNIV 101	The Drexel Experience	2.0
	Humanities/fine arts electives	6.0
	International area studies	6.0
	Foreign language courses	8.0
	Social studies electives	12.0
	Diversity studies electives	6.0

Science requirements*		18.0 Credits
***Students must take one full year of a laboratory science and take courses in more than one science field. (Other options for the laboratory sequence are available; see the Computer Science department for list.)**		
BIO 102	Biology I: Cells and Tissues	4.0
BIO 104	Biology II: Growth and Heredity	4.0
BIO 106	Biology III: Organismal Biology	4.0
or		
CHEM 101	General Chemistry I	3.5
CHEM 102	General Chemistry II	4.5
CHEM 103	General Chemistry III	5.0
or		
PHYS 111	Physics I	4.5
PHYS 112	Physics II	4.5
PHYS 211	Physics III	4.5
	Additional science electives (adding to 18.0 credits total with the chosen laboratory science track)	4.5-6.0

Mathematics requirements		19.0 Credits
MATH 101	Introduction to Analysis I	4.0
MATH 102	Introduction to Analysis II	4.0
MATH 239	Mathematics for the Life Sciences	4.0
MATH 221	Discrete Mathematics	3.0
STAT 201	Statistics I	4.0

Computer science requirements		67.0 Credits
CS 164	Introduction to Computer Science	3.0
CS 171	Computer Programming I	3.0
CS 172	Computer Programming II	3.0
CS 260	Data Structures	3.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
CS 281	Systems Architecture I	4.0
CS 350 WI	Software Design	3.0
CS 360	Programming Language Concepts	3.0
CS 451	Software Engineering	3.0
CS 491	Software Engineering Workshop I	3.0
CS 492	Software Engineering Workshop II	3.0
CS 493	Software Engineering Workshop III	3.0
ECE 200	Digital Logic Design	3.0
	Computer science track* courses	18.0
	Computer science electives	6.0

Other courses		27.5 Credits
	Free electives	27.5

Computer Science Tracks

* Students must complete two of the following Computer Science tracks for a total of 18.0 credits. The tracks may overlap by one course. Students should check with the Department for any additional Special Topics courses being offered that may be appropriate for one of the tracks.

Algorithms and Data Structures		
CS 440	Theory of Computation	3.0
CS 457	Data Structures & Algorithms I	3.0
CS 458	Data Structures & Algorithms II	3.0

Artificial Intelligence

CS 380	**Artificial Intelligence**	3.0
CS 481	**Advanced Artificial Intelligence**	3.0
CS 485	**Special Topics in Artificial Intelligence**	3.0
Computer and Network Security		
CS 472	**Computer Networks**	3.0
CS 475	**Computer and Network Security**	3.0
CS 303	**Algorithmic Number Theory and Cryptography**	3.0
or		
CS 300	**Applied Symbolic Computation**	
Computer Graphics		
CS 430	**Computer Graphics**	3.0
CS 431	**Advanced Rendering Techniques**	3.0
CS 338	**Graphical User Interfaces**	3.0
or		
CS 480	**Special Topics in CS: Interactive Graphics**	
or		
CS 480	**Special Topics in CS: Computational Photography**	
Human-Computer Interactions		
CS 337	**Psychology of Human-Computer Interactions**	3.0
CS 338	**Graphical User Interfaces**	3.0
CS 430	**Computer Graphics**	3.0
or		
CS 345	**Computer Gaming Design**	
or		
CS 480	**Special Topics in CS: Computational Photography**	
Numeric and Symbolic Computation		
CS 300	**Applied Symbolic Computation**	3.0
MATH 300	**Numerical Analysis**	4.0
MATH 305	**Introduction to Optimization Theory**	4.0
or		
MATH 301	**Numeric Solutions to Differential Equations**	3.0
or		
CS 303	**Algorithmic Number Theory and Cryptography**	3.0
Operating Systems		
CS 361	**Concurrent Programming**	3.0
CS 370	**Operating Systems**	3.0
CS 472	**Computer Networks**	3.0
Programming Languages		
CS 440	**Theory of Computation**	3.0
CS 441	**Compiler Workshop I**	3.0
CS 442	**Compiler Workshop II**	3.0

Writing-Intensive Course Requirements

In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline.

Recommended Plan Of Study

BA Computer Science
5 YR UG Co-op Concentration

Term 1		Credits
CS 164	Introduction to Computer Science	3.0
ENGL 101	Expository Writing and Reading	3.0
MATH 101	Introduction to Math Analysis	4.0
UNIV 101	The Drexel Experience	1.0
BIO 102	Biology I: Cells and Tissues	4.0
or		
CHEM 101	General Chemistry I	3.5
or		
PHYS 111	Physics I	4.5
	Term Credits	*15.0*

Term 2		Credits
CS 171	Computer Programming I	3.0
ENGL 102	Persuasive Writing and Reading	3.0
MATH 102	Introduction to Math Analysis	4.0
UNIV 101	The Drexel Experience	0.5
BIO 104	Biology II: Growth and Heredity	4.0
or		
CHEM 102	General Chemistry II	4.5
or		
PHYS 112	Physics II	4.5
	Term Credits	*14.5*

Term 3		Credits
CS 172	Computer Programming II	3.0
ENGL 103	Analytical Writing and Reading	3.0
MATH 239	Mathematics for the Life Sciences	4.0
UNIV 101	The Drexel Experience	0.5
BIO 106	Biology III: Organismal Biology	4.0
or		
CHEM 103	General Chemistry III	5.0
or		
PHYS 211	Physics III	4.5
	Free elective	3.0
	Term Credits	*17.5*

Term 4		Credits
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
	Arts and Humanities elective	3.0
	Diversity studies elective	3.0
	Science elective	3.0
	Term Credits	*15.0*

Term 5		Credits
CS 260	Data Structures	3.0
ECE 200	Digital Logic Design	3.0
MATH 221	Discrete Mathematics	3.0
	Science elective	3.0
	Social science elective	3.0
	Term Credits	*15.0*

Term 6		Credits
CS 281	Systems Architecture I	4.0
CS 350	Software Design	3.0
STAT 201	Statistics I	4.0
	Arts and Humanities elective	3.0
	Social science elective	3.0
	Term Credits	*17.0*

Term 7		Credits
COM 230	Techniques of Speaking	3.0
CS 360	Programming Language Concepts	3.0
	Computer Science elective (See degree requirements for list)	3.0
	Free elective	3.0
	Social studies elective	3.0
	Term Credits	*15.0*

Term 8		Credits
PHIL 311	Computer Ethics	3.0
	Computer Science elective (See degree requirements for list)	6.0
	Free elective	3.0
	Foreign language course	4.0
	Term Credits	*16.0*

Term 9		Credits
CS 451	Software Engineering	3.0
	Computer science electives (See degree requirements)	3.0
	Diversity studies elective	3.0
	Free elective	3.0
	Foreign language course	4.0
	Term Credits	*16.0*

Term 10		Credits
CS 491	Software Engineering Workshop	3.0
	Computer Science elective (See degree requirements for list)	3.0
	Free electives	6.0
	International studies elective	3.0
	Term Credits	*15.0*

Term 11		Credits
CS 492	Software Engineering Workshop II	3.0
	Computer science electives (See degree requirements)	6.0
	Free elective	3.5
	International studies elective	3.0
	Term Credits	*15.5*

Term 12		Credits
CS 493	Software Engineering Workshop III	3.0
	Computer Science elective (See degree requirements for list)	3.0
	Free electives	6.0
	Social science elective	3.0
	Term Credits	*15.0*

	Total Credits (minimum)	186.5

Computer Science

Bachelor of Science Degree: 186.5 credits

Degree Requirements

General education requirements		47.0 Credits
COM 230	**Techniques of Speaking**	3.0
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
PHIL 311	**Computer Ethics**	3.0
UNIV 101	**The Drexel Experience**	2.0
	Business elective	4.0
	Social Studies elective	3.0
	Writing and communication electives*	6.0
	General education electives	17.0

***See the Computer Science Department's web site for a list of approved options for the writing and communication electives.**

Freshmen Design requirements		6.0 Credits
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0

Mathematics requirements		27.0 Credits
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 123	**Calculus III**	4.0
MATH 201	**Linear Algebra**	4.0
MATH 221	**Discrete Mathematics**	3.0
MATH 311	**Probability and Statistics I**	4.0
MATH 312	**Probability and Statistics II**	4.0

Science requirements	25.0 Credits

Twenty-five science credits are required. These must include a three-term sequence from one of the laboratory sciences. (Other options for the laboratory sequence are available; see the Computer Science department for a complete list of acceptable science courses.)

BIO 102	**Biology I: Cells and Tissues**	4.0
BIO 104	**Biology II: Growth and Heredity**	4.0
BIO 106	**Biology III: Organismal Biology**	4.0
or		
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
CHEM 103	**General Chemistry III**	5.0
or		
PHYS 111	**Physics I**	4.5
PHYS 112	**Physics II**	4.5
PHYS 211	**Physics III**	4.5

Computation requirements		**3.0- 4.0 Credits**
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0
or		
MATH 200	**Multivariate Calculus**	4.0

Computer science requirements		**71.0 Credits**
CS 164	**Introduction to Computer Science**	3.0
CS 171	**Computer Programming I**	3.0
CS 172	**Computer Programming II**	3.0
CS 260	**Data Structures**	3.0
CS 265	**Advanced Programming Tools and Techniques**	3.0
CS 270	**Mathematical Foundations of Computer Science**	3.0
CS 281	**Systems Architecture I**	4.0
CS 282	**Systems Architecture II**	4.0
CS 350 WI	**Software Design**	3.0
CS 360	**Programming Language Concepts**	3.0
CS 451	**Software Engineering**	3.0
CS 491	**Software Engineering Workshop I**	3.0
CS 492	**Software Engineering Workshop II**	3.0
CS 493	**Software Engineering Workshop III**	3.0
ECE 200	**Digital Logic Design**	3.0
	Computer science track* courses	18.0
	Computer science electives	6.0

Other courses		**7.5 Credits**
	Free electives	7.5

Computer Science Tracks

* Students must complete two of the following Computer Science tracks for a total of 18.0 credits. The tracks may overlap by one course. Students should check with the Department for any additional Special Topics courses being offered that may be appropriate for one of the tracks.

Algorithms and Data Structures		
CS 440	**Theory of Computation**	3.0
CS 457	**Data Structures & Algorithms I**	3.0
CS 458	**Data Structures & Algorithms II**	3.0
Artificial Intelligence		
CS 380	**Artificial Intelligence**	3.0
CS 481	**Advanced Artificial Intelligence**	3.0
CS 485	**Special Topics in Artificial Intelligence**	3.0
Computer and Network Security		
CS 472	**Computer Networks**	3.0
CS 475	**Computer and Network Security**	3.0
CS 303	**Algorithmic Number Theory and Cryptography**	3.0
or		
CS 300	**Applied Symbolic Computation**	
Computer Graphics		
CS 430	**Computer Graphics**	3.0
CS 431	**Advanced Rendering Techniques**	3.0
CS 338	**Graphical User Interfaces**	3.0
or		
CS 480	**Special Topics in CS: Interactive Graphics**	
or		
CS 480	**Special Topics in CS: Computational Photography**	
Human-Computer Interactions		
CS 337	**Psychology of Human-Computer Interactions**	3.0
CS 338	**Graphical User Interfaces**	3.0
CS 430	**Computer Graphics**	3.0
or		
CS 345	**Computer Gaming Design**	
or		
CS 480	**Special Topics in CS: Computational Photography**	
or		
PSY 330	**Cognitive Psychology**	
Numeric and Symbolic Computation		
CS 300	**Applied Symbolic Computation**	3.0
MATH 300	**Numerical Analysis**	4.0
MATH 305	**Introduction to Optimization Theory**	4.0
or		
MATH 301	**Numeric Solutions to Differential Equations**	3.0
or		
CS 303	**Algorithmic Number Theory and Cryptography**	3.0
Operating Systems		
CS 361	**Concurrent Programming**	3.0
CS 370	**Operating Systems**	3.0
CS 472	**Computer Networks**	3.0
Programming Languages		

CS 132	**Computer Programming B**	3.0
CS 133	**Computer Programming C**	3.0
or		
SE 101	**Fundamentals of Software Engineering I**	3.0
SE 102	**Fundamentals of Software Engineering II**	3.0

Students complete one of the following advanced courses::

CS 265	**Advanced Programming Tools and Techniques**	3.0
SE 103	**Fundamentals of Software Engineering III**	3.0

Theoretical Foundations		**6.0 Credits**
CS 260	**Data Structures**	3.0
CS 270	**Mathematical Foundations of Computer Science**	3.0

Computer Systems		**4.0 Credits**
CS 281	**Systems Architecture I**	4.0

Advanced Electives*		**6.0-7.0 Credits**
Students select two or more courses from the following list. Courses are grouped according to subject area, to assist students in making selections.		
Computing Systems		
CS 282	**Systems Architecture II**	4.0
CS 361	**Concurrent Programming**	3.0
CS 370	**Operating Systems**	3.0
CS 461	**Database Systems**	3.0
CS 472	**Computer Networks**	3.0
Programming Languages and Compilers		
CS 360	**Programming Language Concepts**	3.0
CS 440	**Theory of Computation**	3.0
CS 441	**Compiler Workshop I**	3.0
CS 442	**Compiler Workshop II**	3.0
Human-Computer Interaction		
CS 338	**Graphical User Interfaces**	3.0
CS 430	**Computer Graphics**	3.0
Artificial Intelligence		
CS 380	**Artificial Intelligence**	3.0
CS 481	**Advanced Artificial Intelligence**	3.0
CS 485	**Special Topics in Artificial Intelligence**	3.0
Numeric and Symbolic Computation		
CS 300	**Applied Symbolic Computation**	3.0
MATH 300	**Numerical Analysis**	4.0

CS 440	**Theory of Computation**	3.0
CS 441	**Compiler Workshop I**	3.0
CS 442	**Compiler Workshop II**	3.0

Writing-Intensive Course Requirements

In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog indicates that this course can fulfill a writing-intensive requirement. Departments will designate specific sections of such courses as writing-intensive. Sections of writing-intensive courses are not indicated in this catalog. Students should check the section comments in Banner when registering. Students scheduling their courses in Banner can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term. For more information on writing-intensive courses, see the Drexel University Writing Program's Writing-Intensive Course page.

Recommended Plan Of Study

BS Computer Science
5 YR UG Co-op Concentration

Term 1		Credits
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
CS 164	Introduction to Computer Science	3.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
BIO 102	Biology I: Cells and Tissues	4.0
or		
CHEM 101	General Chemistry I	3.5
or		
PHYS 111	Physics I	4.5
	Term Credits	*18.0*

Term 2		Credits
CS 122	Computation Lab II	1.0
CS 171	Computer Programming I	3.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
UNIV 101	The Drexel Experience	0.5
BIO 104	Biology II: Growth and Heredity	4.0
or		
CHEM 102	General Chemistry II	4.0
or		
PHYS 112	Physics II	4.5
	Term Credits	*17.5*

Term 3		Credits
CS 123	Computation Lab III	1.0
CS 172	Computer Programming II	3.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
UNIV 101	The Drexel Experience	0.5
BIO 106	Biology III: Organismal Biology	4.0
or		
CHEM 103	General Chemistry III	5.0
or		
PHYS 211	Physics III	4.5
	Term Credits	*17.5*

Term 4		Credits
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
MATH 201	Linear Algebra	4.0
	Science elective	3.0
	Social studies elective	3.0
	Term Credits	*16.0*

Term 5		Credits
CS 260	Data Structures	3.0
ECE 200	Digital Logic Design	3.0
MATH 221	Discrete Mathematics	3.0
	Business elective	4.0

	Science elective	3.0
	Term Credits	*16.0*

Term 6		Credits
COM 230	Techniques of Speaking	3.0
CS 281	Systems Architecture I	4.0
CS 350	Software Design	3.0
	General education elective	3.0
	Science elective	3.0
	Term Credits	*16.0*

Term 7		Credits
CS 282	Systems Architecture II	4.0
CS 360	Programming Language Concepts	3.0
	General education elective	3.0
	Science elective	3.0-4.0
	Writing/Communication elective (See approved course list)	3.0
	Term Credits	*16.0-17.0*

Term 8		Credits
MATH 311	Probability and Statistics I	4.0
PHIL 311	Computer Ethics	3.0
	Computer science electives (See degree requirements)	6.0
	General education elective	3.0
	Term Credits	*16.0*

Term 9		Credits
CS 451	Software Engineering	3.0
MATH 312	Probability and Statistics II	4.0
	Computer Science elective (See degree requirements for list)	3.0
	Free elective	3.0
	General education elective	3.0
	Term Credits	*16.0*

Term 10		Credits
CS 491	Software Engineering Workshop	3.0
	Computer science electives (See degree requirements)	6.0
	Free elective	2.0-3.0
	General education elective	3.0
	Term Credits	*14.0-15.0*

Term 11		Credits
CS 492	Software Engineering Workshop II	3.0
	Computer science electives (See degree requirements)	6.0
	General education elective	3.0
	Term Credits	*12.0*

Term 12		Credits
CS 493	Software Engineering Workshop III	3.0
	Computer Science elective (See degree requirements for list)	3.0
	Free elective	3.5
	Writing/Communication elective (See approved course list)	3.0
	Term Credits	*12.5*

	Total Credits (minimum)	187.5-189.5

Minor in Computer Science

The computer science minor provides students with a breadth of knowledge in areas which form the foundation of computer science. The student adds some depth by selecting courses from a list of advanced computer science courses.

Note: students who declared the computer science minor prior to the summer of 2004 (academic year 2003-2004) should contact the Department for more information about the requirements for fulfilling the minor.

Mathematics prerequisites:		**Credits**
One of the following two-term mathematics sequences must be completed before entering the program:		
MATH 101	**Introduction to Analysis I**	4.0
MATH 102	**Introduction to Analysis II**	4.0
or		
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0

Required Courses*:*

Students must complete at least 25 credits from courses listed below, subject to the following restrictions:

- The requirements of each category (*Computer Programming*, *Theoretical Foundations*, *Computer Systems*, and *Advanced Electives*) must be fulfilled
- Not more than 9 credit hours may overlap with those counted toward the student's academic major.
- All courses listed as required must be completed
- Programming courses bypassed through advanced placement do not count toward the 25 credit requirement.
- Remaining credits are to be earned from the list of elective courses.

Computer Programming		**9.0 - 12.0 Credits**
Students complete one of the following introductory course sequences:*:*		
CS 171	**Computer Programming I**	3.0
CS 172	**Computer Programming II**	3.0
or		
CS 131	**Computer Programming A**	3.0

Theory		
CS 440	**Theory of Computation**	3.0
CS 457	**Data Structures & Algorithms I**	3.0
CS 458	**Data Structures & Algorithms II**	3.0
Software Methodology (not available to Software Engineering Students)		
CS 350	**Software Design**	3.0
CS 451	**Software Engineering I**	3.0

***Other courses may be approved by the Department for this purpose; contact the Computer Science Undergraduate Advisor (advisor@cs.drexel.edu).**

Electrical Engineering

The Department of Electrical and Computer Engineering has implemented "ECE 21," the new ECE curriculum for the 21st century. ECE 21 emphasizes computer-aided design and hands-on laboratory experience, and flexibility is a major hallmark of the new program. State-of-the-art interdisciplinary courses have been developed to prepare the Drexel engineer for the technical challenges and the business atmosphere of the 21st century. Strong emphasis is given to the role of the engineer in the global competitive economy, and to the need to work closely with experts and practitioners in many fields.

ECE 21 balances technical depth and breadth: depth through the selection of a track and breadth through courses selected in other tracks and the laboratories. It also provides for special cases and special needs.

The track structure, which starts in the pre-junior year and continues through the end of the senior year, allows students to spend time concentrating in one major area of electrical engineering. The structure can accommodate a number of student types and career objectives. Most students will continue to receive traditional or near-traditional ECE education. Those who have non-ECE career objectives can use the senior year to get exposure to languages, business, or management, for example.

The ECE 21 curriculum offers three different tracks, or areas of study: telecommunications/digital signal processing, electronics, and electrical engineering. To fulfill their track requirements, all ECE students will select eight courses. The majority of the core courses will be in their track, while others will be chosen from other tracks or from the computer engineering program. Descriptions and course requirements for each track follow the basic degree requirements.

Mission Statement

The ECE Department prepares men and women to become leaders working in a highly dynamic and global environment at the forefront of engineering and pursues research to advance the state-of-the-art in electrical and computer engineering and engineering education.

Program Objectives

Our alumni will:

- *Continue as valued, dependable, and competent employees in a wide variety of fields and industries, in particular as electrical engineers,*
- *Succeed in graduate and professional studies, such as engineering, science, law, medicine, and business, if pursued,*
- *Understand the need for life-long learning and continued professional development for a successful and rewarding career,*

- *Accept responsibility for leadership roles, in their profession, in their communities, and in the global society, and*
- *Function as responsible members of society with an awareness of the social and ethical ramifications of their work.*

Electrical Engineering Tracks

Telecommunications/DSP Track

Telecommunications and digital signal processing (DSP) are two of the fastest-growing fields of electrical engineering. The telecommunications/DSP track prepares students for mastery of fundamental and applied knowledge in the theory and the technology of the transmission and processing of information-bearing signals such as voice, audio, data, images, and video. The curriculum includes core courses in electromagnetic propagation, communication devices and media, signal processing, modulation, and coding. Complementary electives can be taken in computers, electronics, control systems, and electric power systems. Senior-level sequence options are available in digital signal processing and communications.

Career opportunities include design and development of digital communications systems and telephony, speech recognition systems, fiber-optic networks, digital radio, medical diagnostic image processing, high-definition television, cellular and wireless communications, satellite communications, networked multimedia communications, and personal communication systems.

Track courses		Credits
ECEE 302	**Electronic Devices**	4.0
ECEE 304	**Electromagnetic Fields and Waves**	4.0
ECES 302	**Transform Methods and Filtering**	4.0
ECES 306	**Introduction to Modulation and Coding**	4.0
ECES 352	**Introduction to Digital Signal Processing**	4.0
ECES 354	**Wireless, Mobile, and Cellular Communications**	4.0
	Additional 300-level core courses	8.0

Electronics Track

The electronics track constitutes the study of electronic and optical semiconductor devices; analog and digital electronic circuits; and generation, transmission, and reception of information both in optical and microwave frequency ranges and guided or free-space conditions.

Career opportunities include jobs in telecommunications (optical, wireless, wired, satellite, and radar), VLSI (analog and digital), aerospace, remote sensing and instrumentation, computer circuitry interface, biomedical instrumentation, semiconductor device fabrication, and transportation.

Track courses		Credits
ECEE 302	**Electronic Devices**	4.0
ECEE 304	**Electromagnetic Fields and Waves**	4.0
ECEE 352	**Analog Electronics**	4.0

ECEE 354	**Introduction to Wireless and Optical Electronics**	4.0
ECES 302	**Transform Methods and Filtering**	4.0
	Additional 300-level core courses	12.0

Electrical Engineering Track

The electrical engineering track has at its core the areas of controls engineering and electric power engineering, the classic core of electrical engineering, and exploits the synergies between these two areas. The track explores subjects such as modeling, analysis and control of dynamic systems including power systems, planning and optimization, electromechanical energy conversion, motor operation and control, transformers, power electronics, sensors and actuators, and the electrical and economic structure of the power industry. The track offers access to two state-of-the-art laboratories. In the Interconnected Power System Laboratory, students can operate and control a small power system through the fusing of computer software and hardware technology with high-voltage, high-power technology. The Ortlip Systems Laboratory houses various experiments in sensing, feedback, and control. Both laboratories stress the use of modeling software, especially MATLAB, and the integrated use of computers and hardware.

Career opportunities include options ranging from manufacturing, the power industry (generation, transmission, distribution, marketing, and consumption), robotics, and transportation to Wall Street.

Track courses		**Credits**
ECEE 302	**Electronic Devices**	4.0
ECEP 352	**Electric Motor Control Principles**	4.0
ECES 302	**Transform Methods and Filtering**	4.0
ECES 304	**Dynamic Systems and Stability**	4.0
ECES 356	**Theory of Control**	4.0
	Additional 300-level core courses	12.0

Electrical Engineering

Required courses

General education requirements		Credits
ECON 201	Economics I	4.0
HIST 285	Technology in Historical Perspective	3.0
ENGL 101	Expository Writing and Reading	3.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGL 103	Analytical Writing and Reading	3.0
PHIL 315	Engineering Ethics	3.0
UNIV 101	The Drexel Experience	2.0
	Liberal studies electives*	15.0

Foundation requirements		Credits
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 200	Multivariate Calculus	4.0
PHYS 101	Fundamentals of Physics I	4.0
PHYS 102	Fundamentals of Physics II	4.0
PHYS 201	Fundamentals of Physics III	4.0
CHEM 101	General Chemistry I	3.5
CHEM 102	General Chemistry II	4.5
BIO 141	Essential Biology	4.5
CS 121	Computational Laboratory I	1.0
CS 122	Computational Laboratory II	1.0
CS 123	Computational Laboratory III	1.0
ECE 200	Digital Logic Design	3.0
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
ENGR 102	Engineering Design Laboratory II	2.0
ENGR 103	Engineering Design Laboratory III	2.0
ENGR 201	Evaluation/Presentation of Experimental Data I	3.0
ENGR 202	Evaluation/Presentation of Experimental Data II	3.0

ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0

Sophomore engineering elective options (Students select one)

ENGR 210	**Introduction to Thermodynamics**	3.0
MATH 221	**Discrete Mathematics**	3.0
PHYS 202	**Fundamentals of Physics IV**	4.0

Professional requirements		**Credits**
ECE 491	**Senior Project Design I**	2.0
ECE 492	**Senior Project Design II**	2.0
ECE 493	**Senior Project Design III**	4.0
ECEL 301	**ECE Laboratory I**	2.0
ECEL 302	**ECE Laboratory II**	2.0
ECEL303	**ECE Laboratory III**	2.0
ECEL 304	**ECE Laboratory IV**	2.0
ENGR 361	**Statistical Analysis of Engineering Systems**	3.0
MATH 291	**Complex and Vector Analysis for Engineers**	4.0
	Additional interdisciplinary courses (1)	3.0
	ECE track courses (8)**	32.0
	ECE technical electives***	9.0-12.0
	Free electives	0.0-6.0

*One liberal studies elective must be in economics (ECON 201). Two liberal studies courses must be in the same area (HIST, PSY, etc).

**Track Courses:

Electrical Engineering Track
ECES 444 Systems and Controls I(4.0), ECES 445 Systems and Controls II (4.0), and ECES 446 Systems and Controls III (4.0);
or
ECEP 411 Power Systems (3.0), ECEP 412 Power Systems II (3.0) and ECEP 413 Power Systems III (3.0).

Electronics Track
ECEE 421 Advanced Electronics I (4.0), ECEE 422 Advanced Electronic Circuits I (3.0), and ECEE 434 Digital Electronics (4.0)
or
ECEE 471 High Frequency Passive Circuits (4.0), ECEE 472 RF Electronics (4.0), and ECEE 473 Antennas and Radiating Systems (4.0)

Telecommunications/DSP Track
ECES 434 Deterministic Signal Processing (4.0), ECES 435 Statistical Signal Processing (4.0), and ECES 436 Speech and Image Signal Interpretation (4.0);
or
ECES 421 Communications I (3.0), ECES 422 Communications II (3.0), and ECES 423 Communications III (3.0).

***ECE Technical electives are 300 or 400-level courses from any Electrical Engineering track.

Recommended Plan Of Study

BS Electrical Engineering
5 YR UG Co-op Concentration /Electrical Engineering

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
ECE 200	Digital Logic Design	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 232	Dynamic Engineering Systems	3.0
	Sophomore engineering elective (See degree requirements for list of options)	3.0-4.0
	Term Credits	*15.0-16.0*

Term 6		Credits
ECEE 302	Electronic Devices	4.0
ECEL 301	ECE Laboratory I	2.0
ECES 302	Transform Methods and Filtering	4.0

HIST 285	Technology in Historical Perspective	3.0
	Free elective	3.0
	Term Credits	*16.0*

Term 7		Credits
ECEL 302	ECE Laboratory II	2.0
ECES 304	Dynamic Systems and Stability	4.0
MATH 291	Complex and Vector Analysis for Engineers	4.0
PHIL 315	Engineering Ethics	3.0
	ECE Core elective (300-level ECE courses from other EE tracks or computer engineering.)	4.0
	Term Credits	*17.0*

Term 8		Credits
ECEL 303	ECE Laboratory III	2.0
ECES 356	Theory of Control	4.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
	ECE Core elective (300-level ECE courses from other EE tracks or computer engineering.)	4.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 9		Credits
ECEL 304	Electrical Engineering Laboratory IV	2.0
ECEP 352	Electric Motor Control Principles	4.0
	ECE Core elective (300-level ECE courses from other EE tracks or computer engineering.)	4.0
	Interdisciplinary course	3.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 10		Credits
ECE 491	Senior Design I	2.0
ECES 444	Systems and Control I	4.0
or		
ECEP 411	Power Systems I	3.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Free elective	3.0
	Liberal studies elective	3.0
	Term Credits	*15.0-16.0*

Term 11		Credits
ECE 492	Senior Design II	2.0
ECEP 412	Power Systems II	4.0
or		
ECES 445	Systems and Control II	4.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Free elective	2.5
	Liberal studies elective	3.0
	Term Credits	*14.5-15.5*

Term 12		Credits
ECE 493	Senior Design III	4.0
ECEP 413	Power Systems III	3.0
or		
ECES 446	Systems and Control III	4.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Liberal studies elective	3.0
	Term Credits	*13.0-14.0*

	Total Credits (minimum)	193.0-197.0

Minor in Electrical Engineering

The Electrical Engineering minor is designed to provide other engineering majors or students from other disciplines an introduction to the wide-ranging content of the electrical engineering major. The minor consists of a minimum of eight ECE courses resulting in 26 credits. There are five required courses and an additional 12 credits of elective courses.

Prerequisites
The minor assumes that students will have a background in mathematics and physics equivalent to that covered in the first two years of the engineering curriculum. In mathematics, this would cover calculus and differential equations. Knowledge of linear algebra is also recommended. Courses taken to meet these requirements will not count toward the minor.

Required courses		**14.0 Credits**
ECE 200	**Digital Logic Design**	3.0
ECE 201	**Fundamentals of Electrical Circuits**	3.0
ECES 302	**Transform Methods & Filtering**	4.0
ECEL 301	**ECE Laboratory I**	2.0
ECEL 302	**ECE Laboratory II**	2.0

Electives **12.0 Credits**
Students should choose 12 credits from 300- and/or 400-level ECE courses. These courses can come from the Computer (ECEC), Electrophysics (ECEE), Electric Power (ECEP), or Systems (ECES) groups. All prerequisites must be satisfied.

The Electrical Engineering Minor for Computer Engineering Students
The University limit on overlap between major and minor programs is 9 credits. Since all of the required courses in the EE minor are also in the CE degree program, computer engineering students will be required to add at least 5 additional EE credits to their minor plan of study in consultation with their academic advisor. Computer Engineering majors may only choose their elective courses from the ECEE, ECEP, and ECES course groups.

Environmental Engineering

Environmental engineering is concerned with protecting human, animal, and plant populations from the effects of adverse environmental factors, including toxic chemicals and wastes, pathogenic bacteria, and global warming.

Environmental engineers also try to minimize the effect of human activities on the physical and living environment so that we can all live more healthy lives.This field builds on other branches of engineering, especially civil, chemical, and mechanical engineering. It also builds on information from many of the sciences, such as chemistry, physics, hydrology, geology, atmospheric science, and several specializations of biology (ecology, microbiology, and biochemistry). Students who elect to study environmental engineering will become familiar with many of these areas because maintaining and improving the environment requires that problems be evaluated and solutions found using a multidisciplinary approach.

Mission
The mission of the undergraduate environmental engineering program at Drexel University is to graduate outstanding engineers who can identify, evaluate and solve complex environmental problems, and who desire to continue their education on a lifelong basis.

Program Objectives
Environmental engineering graduates will become professionals who analyze, design, construct, manage or operate facilities or systems to protect or enhance the environment of people and other living things, or advance knowledge of the field.

For more information about this major, visit the Civil, Architectural and Environmental Engineering Department and the B.S. in Environmental Engineering page.

Environmental Engineering

Bachelor of Science Degree: 198.5 credits

General education requirements		Credits
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
ENGR 361	**Statistical Analysis of Engineering Systems**	4.0
PHIL 315	**Engineering Ethics**	3.0
UNIV 101	**The Drexel Experience**	2.0
	Liberal studies electives	15.0

Engineering core courses		Credits
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0
PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0
ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ENGR 201	**Evaluation/Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation/Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0
ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0

Environmental engineering requirements		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	3.0
CHE 201	Process Material Balances	3.0
CHEM 230	Quantitative Analysis	3.0
CHEM 231 WI	Quantitative Analysis Laboratory	2.0
CHEM 241	Organic Chemistry I	4.0
CHEM 242	Organic Chemistry II	4.0
CIVE 240	Engineering Economic Analysis	3.0
CIVE 320	Fundamentals of Fluid Flow	4.0
CIVE 330	Hydraulics I	3.0
CIVE 430	Hydrology	3.0
CIVE 431	Ground Hydrology	3.0
ENVE 300	Introduction to Environmental Engineering	3.0
ENVE 302	Environmental Transport and Kinetics	3.0
ENVE 410	Solid and Hazardous Waste	3.0
ENVE 421	Water and Waste Treatment II	3.0
ENVE 422	Water and Waste Treatment Design	3.0
ENVR 451	Atmospheric Environment	3.0
or		
ENVE 435	Groundwater Remediation	
ENVE 460	Fundamentals of Air Pollution Control	3.0
ENVE 485	Professional Environmental Engineering Practice	1.0
ENVE 486	Environmental Engineering Processing Lab I	2.0
ENVE 487	Environmental Engineering Processing Lab II	2.0
ENVE 491	Senior Project Design I	3.0
ENVE 492	Senior Project Design II	3.0
ENVE 493	Senior Project Design III	3.0
ENVR 284 WI	Ecology I: Physiological and Population Ecology	5.0
or		
BIO 221	Microbiology	5.0
ENVR 401	Chemistry of the Environment	3.0
	Technical electives	12.0

Recommended Plan Of Study

BS Environmental Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
ENGL 103	Analytical Writing and Reading	3.0
	Term Credits	*19.0*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
BIO 221	Microbiology	5.0
or		
ENVR 284	Ecology I: Physiological and Population Ecology	5.0
	Term Credits	*17.0*

Term 6		Credits
CHE 201	Process Material Balances	3.0

CHEM 230	Quantitative Analysis	3.0
CHEM 231	Quantitative Analysis Laboratory	2.0
CIVE 320	Fundamentals of Fluid Flow	4.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
ENVE 300	Introduction to Environmental Engineering	3.0
	Term Credits	*18.0*

Term 7		Credits
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	4.0
CIVE 330	Hydraulics	3.0
ENVE 302	Environmental Transport and Kinetics	3.0
PHIL 315	Engineering Ethics	3.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 8		Credits
CHEM 241	Organic Chemistry I	4.0
CIVE 240	Engineering Economic Analysis	3.0
CIVE 430	Hydrology	3.0
	Liberal studies elective	3.0
	Technical elective	3.0
	Term Credits	*16.0*

Term 9		Credits
CHEM 242	Organic Chemistry II	4.0
	Free elective	3.0
	Liberal studies elective	3.0
	Technical elective	3.0
	Term Credits	*13.0*

Term 10		Credits
ENVE 485	Professional Environmental Engineering Practice	1.0
ENVE 491	Senior Project Design I	3.0
ENVR 401	Chemistry of the Environment	3.0
ENVE 460	Fundamentals of Air Pollution Control	3.0
or		
ENVE 480	Topics in Environmental Engineering: Indoor Air	3.0
	Liberal studies elective	3.0
	Technical elective	3.0
	Term Credits	*16.0*

Term 11		Credits
CIVE 431	Hydrology-Ground Water	3.0
ENVE 410	Solid and Hazardous Waste	3.0
ENVE 421	Water and Waste Treatment II	3.0
ENVE 486	Environmental Engineering Processes Laboratory I	2.0
ENVE 492	Senior Design Project II	3.0
	Technical elective	3.0
	Term Credits	*17.0*

Term 12		Credits
ENVE 422	Water and Waste Treatment Design	3.0
ENVE 435	Groundwater Remediation	3.0
ENVE 487	Environmental Engineering Processes Laboratory II	2.0
ENVE 493	Senior Design Project III	4.0
	Term Credits	*12.0*

	Total Credits (minimum)	195.5

Minor in Environmental Engineering

The Environmental Engineering minor focuses on pollution control and is primarily designed to broaden the professional capabilities of engineering students. For example, chemical and mechanical engineers working in process and manufacturing plants will be provided with a better understanding of the natural context of their facilities, better equipped to perform fate and risk analyses, and better able to apply the appropriate technology to control air and water discharges.

While this minor is designed to provide technical knowledge and skills to other engineers, with the appropriate prerequisites students from disciplines other than engineering can also complete this minor.

The minor consists of 24 credits, with five core required courses and nine additional credits taken from a list of options.

Prerequisites
The common engineering core curriculum prerequisites are required of all students in the College of Engineering. Students from other colleges will need the appropriate background in physics, mathematics and thermodynamics.

Required courses		**15.0 Credits**
CAEE 210	**Measurements in Civil, Architectural and Environmental Engineering I**	3.0
ENVE 300	**Introduction to Environmental Engineering**	3.0
ENVE 302	**Environmental Transport and Kinetics**	3.0
CIVE 330	**Hydraulics**	3.0
ENVR 401	**Chemistry of the Environment**	3.0

		9.0 Credits
Students select a minimum of nine additional credits from the following:		
ENVE 410	**Solid and Hazardous Waste**	3.0
ENVE 460	**Fundamentals of Air Pollution Control**	3.0
ENVE 486	**Environmental Engineering Processing Lab I**	2.0
ENVE 487	**Environmental Engineering Processing Lab II**	2.0
CIVE 430	**Hydrology**	3.0

Materials Engineering

Materials engineering is concerned with the production, properties, and utilization of metals, ceramics, polymers, composites, electronic, optical, nano- and bio-compatible materials. Materials engineers play a key role in our increasingly complex technological society by extending the limited supply of materials, improving existing materials, and developing new and superior materials and processes with an awareness of the cost, reliability, safety, and social/ environmental implications.

Students majoring in materials engineering receive a thorough grounding in the basic sciences and engineering of all materials. All students are required to take course sequences that include materials processing, thermodynamics and kinetics of materials, and their physical and mechanical behavior, plus laboratories designed to familiarize them with the instruments and techniques used to characterize materials and evaluate their performance. In addition, several required senior courses emphasize the role of materials selection and specification in design.

A required senior design project, a wide variety of technical elective courses, and co-op experiences allow students in-depth exploration of selected areas. A minor in materials engineering is also available.

Mission Statement
The Department of Materials Science and Engineering program will provide our B. S., M.S. and Ph.D. graduates with the technical and theoretical knowledge, design capabilities, professionalism, and communications skills necessary for them to excel in leadership positions in academia, industry, and government at the national and international levels.

Vision
Materials science and engineering is a multi-disciplinary field that will remain at the forefront of all emerging technologies. Advances in the understanding of the process-structure-property-performance relationships of materials will be critical for future developments in energy storage and power generation, biomaterials and nanomaterials. The Department of Materials Science and Engineering at Drexel University will be recognized as a world leader in these areas, through its teaching and scholarly research.

Program Educational Objectives (PEOs)
The Educational Objectives of the Materials Engineering B. S. degree program are:

1. Materials Engineering program graduates will possess the core technical

competencies in their field necessary to successfully interface with other engineering disciplines in the workplace.
2. At least 30% of Materials Engineering program graduates will progress towards graduate education.
3. Materials Engineering program graduates will become leaders in their chosen fields.
4. Materials Engineering program graduates will have the ability to engage in lifelong learning.
5. Materials Engineering program graduates will have written and verbal communication skills appropriate for professional materials engineers.

Program Outcomes

The department's Program Outcomes reflect the skills and abilities which the curriculum is designed to provide to students by the time they graduate. These are:

a. An ability to apply a knowledge of mathematics, science, and engineering.
b. An ability to design and conduct an experimental investigation, as well as analyze and interpret data using statistical, computational and mathematical methods.
c. An ability to design and/or select a material, system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
d. Ability to function on multi-disciplinary teams.
e. An ability to identify, formulate, and solve materials engineering problems.
f. A knowledge and understanding of professional and ethical responsibility.
g.1 An ability to communicate effectively – Oral.
g.2 An ability to communicate effectively – Written.
h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
i. A recognition of the need for, and an ability to engage in, lifelong learning.
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for materials engineering practice.

Senior Design Projects

Throughout the senior year, students majoring in materials engineering work on a capstone senior design project with guidance from a faculty advisor. Students, working individually or in small groups, synthesize information from their courses to arrive at solutions to real-world engineering problems.

Some recent senior design projects include:

1. Platinum Enhanced Polymer-Carbon Nanotube Nano-Hybrid Shish-Kebab Structures for Use as Fuel Cell Catalysts.
2. Injectable Polyurethanes Designed for Vertebroplasty.
3. Abnormal Grain Coarsening In Al-Fe Alloys.
4. The Impact of Roller Compaction Parameters on Ribbon Quality.
5. Mechanical Characterization of Nanocomposite Materials.

Materials Engineering

Bachelor of Science Degree: 192.0 credits

Required courses

General education requirements		Credits
ECON 201	**Economics I**	4.0
ECON 202	**Economics II**	4.0
HIST 285	**Technology in Historical Perspective**	3.0
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
PHIL 315	**Engineering Ethics**	3.0
UNIV 101	**The Drexel Experience**	2.0
	Technical electives	9.0
	Liberal studies electives	9.0
	Free elective	3.0

Foundation requirements

CHE 310	**Transport Phenomena**	4.0
CHE 335	**Statistics and Design of Experiments**	3.0
CHEC 353	**Physical Chemistry and Applications III**	4.0
CHEM 241	**Organic Chemistry I**	4.0
PHYS 451	**Quantum Structure of Materials**	4.0
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0
PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5
CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0

ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ENGR 201	**Evaluation/Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation/Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0
ENGR 220	**Fundamentals of Materials**	4.0
ENGR 231	**Linear Engineering Systems**	3.0
ENGR 232	**Dynamic Engineering Systems**	3.0

Professional requirements

MATE 214	**Introduction to Polymers**	4.0
MATE 221	**Introduction to Mechanical Behavior of Materials**	3.0
MATE 240	**Thermodynamics of MaterialsI**	4.0
MATE 245	**Kinetics of Materials**	4.0
MATE 280	**Advanced Materials Laboratory**	4.0
MATE 315	**Processing of Polymers**	4.5
MATE 340	**Fundamentals of Ceramics**	4.0
MATE 345	**Processing of Ceramics**	4.5
MATE 362	**Microstructure of Metallic Materials**	4.0
MATE 366 WI	**Processing of Metallic Materials**	4.5
MATE 370	**Mechanical Behavior of Solids**	3.0
MATE 410	**Case Studies in Materials**	3.0
MATE 455	**Biomedical Materials**	3.0
MATE 460	**Engineering Computational Laboratory**	4.0
MATE 491 WI	**Senior Project Design I**	2.0
MATE 492	**Senior Project Design II**	2.0
MATE 493 WI	**Senior Project Design III**	4.0

Writing-Intensive Course Requirements
In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog indicates that this course can fulfill a writing-intensive requirement. Departments will designate specific sections of such courses as writing-intensive. Sections of writing-intensive courses are not indicated in this catalog. Students should check the section comments in Banner when registering. Students scheduling their courses in Banner can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term. For more information on writing-intensive courses, see the Drexel University Writing Program's Writing-Intensive Course page.

Drexel University
Catalog 2007 / 2008

Recommended Plan Of Study

BS Materials Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	***15.5***

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	***19.0***

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	***19.0***

Term 4		Credits
CHEM 241	Organic Chemistry I	4.0
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	***18.0***

Term 5		Credits
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MATE 221	Introduction to Mechanical Behavior of Materials	3.0
	Liberal studies elective	3.0
	Term Credits	***15.0***

Term 6		Credits
HIST 285	Technology in Historical Perspective	3.0
MATE 214	Introduction to Polymers	4.0
MATE 240	Thermodynamics of Materials	4.0
MATE 362	Microstructures of Metallic Materials	4.0

MATE 455	Biomedical Materials	3.0
	Term Credits	*18.0*

Term 7		Credits
MATE 245	Kinetics of Materials	4.0
MATE 315	Processing of Polymers	4.5
MATE 370	Mechanical Behavior of Solids	3.0
PHIL 315	Engineering Ethics	3.0
	Term Credits	*14.5*

Term 8		Credits
CHE 310	Transport Phenomenona	4.0
ECON 201	Economics I	4.0
MATE 280	Advanced Materials Laboratory	4.0
MATE 340	Fundamentals of Ceramics	4.0
	Term Credits	*16.0*

Term 9		Credits
CHEC 353	Physical Chemistry and Applicatons II	4.0
ECON 202	Economics II	4.0
MATE 345	Processing of Ceramics	4.5
MATE 366	Processing of Metallic Materials	4.5
	Term Credits	*17.0*

Term 10		Credits
CHE 335	Statistics and Design of Experiments	3.0
MATE 460	Engineering Computational Laboratory	4.0
MATE 491	Senior Design I	2.0
PHYS 451	Quantum Structure of Materials	4.0
	Term Credits	*13.0*

Term 11		Credits
MATE 410	Case Studies in Materials	3.0
MATE 492	Senior Design II	2.0
	Free elective	3.0
	Liberal studies elective	3.0
	Technical elective	3.0
	Term Credits	*14.0*

Term 12		Credits
MATE 493	Senior Design III	4.0
	Liberal studies elective	3.0
	Technical electives	6.0
	Term Credits	*13.0*

	Total Credits (minimum)	192.0

Minor in Materials Engineering

In addition to the core engineering curriculum and the courses required for majors in chemical, civil, electrical or mechanical engineering, students electing to pursue a minor in materials engineering must also fulfill the following requirements.

Required courses		Credits
MATE 221	**Introduction to Mechanical Behavior of Materials**	3.0
At least 21.0 credits from the following courses		
MATE 214	**Introduction to Polymers***	4.5
MATE 240	**Thermodynamics of Materials**	4.0
MATE 340	**Fundamentals of Ceramics**	4.0
MATE 364	**Microstructure of Metallic Materials**	3.5
MATE 370	**Mechanical Behavior of Solids****	3.0
PHYS 451	**Quantum Structure of Materials**	4.0

*MATE 214 requires CHEM 241 as a pre-requisite. If MATE 214 is elected, the credits for CHEM 241 can count toward the 21 credits.

**MATE 370 requires MATH 201 as a pre-requisite. If MATE 370 is elected, the credits for MATH 201 can count toward the 21 credits.

Note: Only one of the pre-requisites (either CHEM 241 or MATH 201) can count toward the required 21.0 credits. In other words, both MATE 214 and MATE 370 can be used to fulfill the requirement, but only the pre-requisite for one of those courses will be calculated into the 21.0 credits. Similarly, MATH 201 or CHEM 241 cannot be counted alone as fulfilling this minor. The credits for MATH 201 or CHEM 241 will only count toward the minor when the course is are taken as a prerequisite for MATE 214 or MATE 370.

Substitution for these courses of equivalent courses offered by other departments and/or institutions may be made with the approval of the Department of Materials Engineering on a case-by-case basis. At least two-thirds of the content of a substitute course must be the same as that of the course in the list above. Students pursuing the minor are encouraged to select a senior design topic that is relevant to materials.

Mechanical Engineering and Mechanics

The role of the mechanical engineer in today's society is rapidly changing. Advances in manufacturing, transportation, infrastructure systems, materials, communications, and high-performance computing have introduced new demands, opportunities, and challenges for mechanical engineers. What was once an individual endeavor has now become a team activity. Today's industries require that mechanical engineers possess diverse interdisciplinary skills, a global viewpoint, entrepreneurial and managerial abilities, and an understanding of the forces governing the marketplace.

Traditionally, mechanical engineers have been associated with industries like automotive, transportation, and power generation, and with activities involving the design, analysis, and manufacturing of products useful to society. While today such activities are still dominated by mechanical engineers, the spectrum of opportunities for these professionals has expanded tremendously. For example, mechanical engineers are involved in the design and analysis of biomedical instrumentation, electronic components, smart structures, and advanced materials; they are involved in sophisticated studies of human motion, control of satellites, and the development of more efficient energy-transfer techniques.

Drexel's Department of Mechanical Engineering and Mechanics prides itself on providing its students with a comprehensive program of courses, laboratories, design projects, and co-op experiences. The MEM curriculum is designed to balance technical breadth (provided by a set of fundamental required core courses) with technical depth (provided by optional concentrations that emphasize particular fields within the profession). Thus, the MEM program not only prepares its graduates to become successful mechanical engineers needed in industry and government, but also provides an excellent springboard to pursue graduate studies in medical sciences, law, business, information technology, and any other disciplines where technological and analytical skills play an important role.

A minor in mechanical engineering is available to students majoring in other disciplines. The minor consists of 16 credits in the core curriculum and at least 8 credits of elective courses.

Mission Statement

The mission of the Department of Mechanical Engineering and Mechanics of Drexel University is to transfer and acquire knowledge through: (a) the education of engineers for leadership in industry, business, academia, and government; and (b) the establishment of internationally recognized research programs. This mission is accomplished by the delivery of an outstanding curriculum, by the participation of our students in one of the nation's most prestigious co-operative educational programs, and by the scholarly activities of the faculty.

Program Objectives

- Our graduates will be successful in careers that deal with the design, simulation and analysis of engineering systems, experimentation and testing, manufacturing, technical services, and research.
- Our graduates will enter and complete academic and professional programs in engineering, business, management, law and medicine.
- Our graduates will communicate effectively with peers and be successful working with and leading multi-disciplinary and multi-cultural teams.
- Our graduates will recognize the global, legal, societal, and ethical contexts of their work.
- Our graduates will advance in their careers; for example, assuming increasing levels of responsibility and acquiring professional licensure.

Mechanical Engineering and Mechanics

Bachelor of Science Degree: 195.0 credits

Required courses

Mathematics requirements		Credits
MATH 290	**Math Modeling for Engineers**	4.0
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 200	**Multivariate Calculus**	4.0

Physics requirements

PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
PHYS 201	**Fundamentals of Physics III**	4.0

Chemistry/biology requirements

CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
BIO 141	**Essential Biology**	4.5

Design/laboratory requirements

CS 121	**Computational Laboratory I**	1.0
CS 122	**Computational Laboratory II**	1.0
CS 123	**Computational Laboratory III**	1.0
ENGR 100	**Beginning CAD for Design**	1.0
ENGR 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0

Engineering requirements

ENGR 201	**Evaluation and Presentation of Experimental Data I**	3.0
ENGR 202	**Evaluation and Presentation of Experimental Data II**	3.0
ENGR 210	**Introduction to Thermodynamics**	3.0
ENGR 231	**Linear Engineering Systems**	3.0

ENGR 232	**Dynamic Engineering Systems**	3.0

Engineering economics requirements

CIVE 240	**Project Economics and Decisions**	3.0

Liberal studies requirements

HIST 285	**Technology in Historical Perspective**	3.0
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
PHIL 315	**Engineering Ethics**	3.0
UNIV 101	**The Drexel Experience**	2.0

Materials requirements

ENGR 220	**Fundamentals of Materials**	4.0

Mechanical requirements

MEM 201	**Fundamentals of Computer Aided Design**	3.0
MEM 202	**Engineering Mechanics: Statics**	3.0
MEM 220	**Basic Fluid Mechanics**	4.0
MEM 230	**Mechanics of Materials I**	4.0
MEM 238	**Engineering Mechanics: Dynamics**	4.0
MEM 255	**Introduction to Controls**	4.0
MEM 310	**Thermodynamic Analysis I**	4.0
MEM 311	**Thermal Fluid Science Laboratory**	2.0
MEM 331	**Experimental Mechanics Laboratory**	2.0
MEM 351	**Dynamic Systems Laboratory**	2.0
MEM 345	**Heat Transfer**	4.0
MEM 355	**Performance Enhancement of Dynamic Systems**	4.0
MEM 361	**Engineering Reliability**	3.0
MEM 435	**Introduction to CAD/CAM**	4.0
MEM 491	**Senior Design I**	3.0
MEM 492	**Senior Design II**	3.0
MEM 493	**Senior Design III**	3.0

Elective courses		**Credits**
	Liberal studies	12.0
	MEM advanced fundamental courses*	12.0
	MEM electives**	6.0-8.0
	COE electives***	6.0-8.0
	COE//SCI/BUS electives******	6.0-8.0
	Free electives	6.0-8.0

* All MEM students must complete a minimum of four of the advanced MEM fundamentals courses

** Any two MEM courses 300 level or higher.

***Any two College of Engineering (including MEM) courses 300 level or higher.

***Any two College of Engineering (including MEM) courses or science or business courses 300 level or higher.

Advanced MEM Fundamental Courses		Credits
MEM 320	**Fluid Dynamics I**	3.0
MEM 330	**Mechanics of Materials II**	4.0
MEM 410	**Thermodynamics Analysis II**	3.0
MEM 417	**Introduction to Microfabrication**	3.0
MEM 423	**Mechanics of Vibration**	4.0
MEM 431	**Machine Design I**	3.0
MEM 437	**Manufacturing Processes**	3.0
MEM 440	**Thermal Systems Design**	3.0
MEM 458	**Microcomputer-Based Control Systems I**	3.0
MEM 459	**Microcomputer-Based Control Systems II**	3.0

Recommended Plan Of Study

BS Mechanical Engineering and Mechanics
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
COOP 101	Career Management/Professional Development	0.0
CS 121	Computation Lab I	1.0
ENGL 101	Expository Writing and Reading	3.0
ENGR 100	Beginning CAD for Design	1.0
ENGR 101	Engineering Design Laboratory I	2.0
MATH 121	Calculus I	4.0
UNIV 101	The Drexel Experience	1.0
	Term Credits	*15.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 102	Persuasive Writing and Reading	3.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 3		Credits
BIO 141	Essential Biology	4.5
CS 123	Computation Lab III	1.0
ENGL 103	Analytical Writing and Reading	3.0
ENGR 103	Engineering Design Laboratory III	2.0
MATH 200	Multivariate Calculus	4.0
PHYS 102	Fundamentals of Physics II	4.0
UNIV 101	The Drexel Experience	0.5
	Term Credits	*19.0*

Term 4		Credits
ENGR 201	Evaluation & Presentation of Experimental Data I	3.0
ENGR 220	Fundamentals of Materials	4.0
ENGR 231	Linear Engineering Systems	3.0
MEM 202	Engineering Mechanics: Statics	3.0
PHYS 201	Fundamentals of Physics III	4.0
	Term Credits	*17.0*

Term 5		Credits
ENGR 202	Evaluation & Presentation of Experimental Data II	3.0
ENGR 210	Introduction to Thermodynamics	3.0
ENGR 232	Dynamic Engineering Systems	3.0
MEM 201	Fundamentals of Computer-Aided Design	3.0
MEM 238	Engineering Mechanics: Dynamic	4.0
	Term Credits	*16.0*

Term 6		Credits
CIVE 240	Engineering Economics Analysis	3.0
HIST 285	Technology in Historical Perspective	3.0
MATH 290	Linear Modeling for Engineers	4.0
MEM 230	Mechanics of Materials I	4.0

MEM 310	Thermal Analysis	4.0
	Term Credits	*18.0*

Term 7		Credits
MEM 380	Special Topics in Mechanical Engineering	3.0
MEM 220	Basic Fluid Mechanics	4.0
MEM 255	Introduction to Controls	4.0
MEM 331	Experimental Mechanics Laboratory	2.0
PHIL 315	Engineering Ethics	3.0
	Term Credits	*16.0*

Term 8		Credits
MEM 311	Thermal Fluid Science Laborato	2.0
MEM 355	Performance Enhancement of Dynamic Systems	4.0
MEM 435	Introduction to CAD/CAM	4.0
MEM 345	Heat Transfer	4.0
	Advanced MEM Fundamentals course (see degree requirements list)	3.0-4.0
	Term Credits	*17.0-18.0*

Term 9		Credits
MEM 351	Dynamic Systems Laboratory	2.0
MEM 361	Engineering Reliability	3.0
	Liberal studies elective	3.0-4.0
	Advanced MEM Fundamentals course (see degree requirements list)	3.0-4.0
	Two MEM or MEM/COE or MEM/SCI/BUS electives (see degree requirements)	6.0-8.0
	Term Credits	*17.0-21.0*

Term 10		Credits
MEM 491	Senior Design I	3.0
	Liberal studies elective	3.0-4.0
	Advanced MEM Fundamentals course (see degree requirements list)	3.0-4.0
	Two MEM or MEM/COE or MEM/SCI/BUS electives (see degree requirements)	6.0-8.0
	Term Credits	*15.0-19.0*

Term 11		Credits
MEM 492	Senior Design II	3.0
	Liberal studies elective	3.0-4.0
	Advanced MEM Fundamentals course (see degree requirements list)	3.0-4.0
	Two MEM or MEM/COE or MEM/SCI/BUS electives (see degree requirements)	6.0-8.0
	Term Credits	*15.0-19.0*

Term 12		Credits
MEM 493	Senior Project Design III	3.0
	Free electives	6.0-8.0
	MEM elective or MEM/COE elective or MEM/SCI/BUS elective (see degree requirements)	3.0-4.0
	Term Credits	*12.0-15.0*
	Total Credits (minimum)	196.5-212.5

Aerospace

The concentration in Aerospace provides students with the opportunity of learning and integrating multiple engineering disciplines. Emphasis is placed on structural, aerodynamic, guidance and control and propulsion problems related to air and space vehicles. Career opportunities can be found in the fields of design of air vehicles, auto-pilot design, design of structural components and propulsion systems.

Recommended courses		Credits
MEM 320	**Fluid Dynamics I**	3.0
MEM 330	**Mechanics of Materials II**	4.0
MEM 423	**Mechanics of Vibrations**	4.0
MEM 420	**Aerodynamics**	3.0
MEM 425	**Aircraft Design/Performance**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Engineering Finite Element Analysis**	3.0
MEM 428	**Introduction to Composites I**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Gas Turbines/Jet Propulsion**	3.0
MEM 426	**Aerospace Structures**	3.0
MEM 453	**Aircraft Flight Dynamics & Control I**	3.0
MEM 454	**Aircraft Flight Dynamics & Control II**	3.0

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Biomechanical Engineering

Biomechanical engineering is a large and expanding area related to the application of mechanical engineering principles in the medical field. It includes diverse areas such as orthopedics, cardiovascular engineering, medical robotics, rehabilitation, sports, forensic engineering, injury protection and tissue engineering. Career opportunities may be found in the medical, rehabilitation and sports industries; in medical research at hospital laboratories and institutes of higher education and in working as consultants and expert advisors to the industrial, legal and medical communities.

Recommended courses		Credits
MEM 502	**Biofluid Dynamics**	3.0
MEM 684	**Mechanics of Biological Tissues**	3.0
MEM 475	**Medical Robotics I**	3.0
MEM 478	**Computer-Aided Tissue Engineerng**	4.0
MEM 685	**Mechanics of Human Joints**	4.0
MEM 686	**Mechanics of Human Motion**	3.0
MEM 476	**Medical Robotics II**	3.0
BMES 680	**Special Topics: CAD/CAM in Biomedical and Tissue Engineering**	2.0
MATE 661	**Biomedical Materials I**	3.0
MATE 662	**Biomedical Materials II**	3.0
ANAT 101	**Anatomy and Physiology I**	5.0
ANAT 102	**Anatomy and Physiology II**	5.0
MEM 800	**Special Topics: Introduction to Forensic Biomechanics**	3.0

For more detailed information regarding the requirements for the Biomechanical Engineering area of concentration, visit the Biomechanical Engineering Concentration at the Department of Mechanical Engineering and Mechanics site.

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Design and Manufacturing

The concentration in Design and Manufacturing provides students with the basic concepts related to manufacturing processes, product design, management of computer-integrated systems and the application of modern numerical tools for the design and analysis of complex devices. Industries ranging from automotive to electronics provide excellent career opportunities to students following this concentration.

Recommended courses		Credits
MEM 380	**Special Topics in Mechanical Engineering: Design, Analysis and Simulation for Manufacturing**	3.0
MEM 437	**Manufacturing Process I**	3.0
MEM 438	**Manufacturing Process II**	3.0
MEM 330	**Mechanics of Materials**	4.0
MEM 431	**Machine Design**	3.0
MEM 455	**Introduction to Robotics**	3.0
MEM 456	**Robotics II**	3.0
MEM 458	**Microcomputer-Based Control Systems I**	3.0
MEM 459	**Microcomputer-Based Control Systems II**	3.0
MEM 462	**Introduction to Engineering Management**	3.0
MEM 427	**Introduction to Finite Element Methods**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Quality Engineering I**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Quality Engineering II**	3.0
MEM 717	**Heat Transfer in Manufacturing Processes**	3.0

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Mechanics and Structures

Students following this concentration are exposed to the foundations of the static and dynamic analysis of structures and machines from a theoretical and computational point of view. Emphasis is placed on the mechanical behavior of structures and machine parts, failure mechanisms, advanced materials, and use of finite elements for stress analysis of complex structures. Career opportunities are found virtually in any technological field where issues such as reliability and failure of materials and structures are of utmost importance, including buildings, aircraft, machine components, electronic parts, and biomechanical systems.

Recommended courses		Credits
MEM 330	**Mechanics of Materials II**	4.0
MEM 423	**Mechanics of Vibrations**	4.0
MEM 430	**Advanced Stress Analysis**	4.0
MEM 431	**Machine Design I**	3.0
MEM 427	**Introduction to Finite Element Methods**	3.0
MEM 428	**Introduction to Composites I**	3.0
MEM 429	**Introduction to Composites II**	3.0
MEM 424	**Biomechanics**	3.0

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Systems and Control

This concentration is designed for students with an interest in the analysis, control, and design of dynamic systems. Topics in this track include various aspects of robotic motion and robotic-based automated manufacturing and hands-on experience in real-time control and manipulation of hardware dynamic systems. Career opportunities include those of aircraft guidance and control systems in automotive, chemical, and power plants.

Recommended courses		Credits
MEM 458	**Microcomputer-based Control Systems I**	3.0
MEM 459	**Microcomputer-based Control Systems II**	4.0
MEM 425	**Aircraft Design/Performance**	4.0
MEM 455	**Introduction to Robotics**	3.0
MEM 456	**Robotics II**	3.0
MEM 453	**Aircraft Flight Dynamics & Control I**	3.0
MEM 454	**Aircraft Flight Dynamics & Control II**	3.0
MEM 457	**Robotics III**	3.0

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Thermal and Fluid Sciences

This concentration provides students with a background in fluid motion, heat transfer, combustion, HVAC (heating, ventilation, and air conditioning), and applied thermo dynamics. These courses prepare students for careers in a multitude of large and small companies where the transfer of liquids, gases, and/or energy from one location to another is required. Potential employers include companies in the aerospace, automotive, chemical processing, power generation, and HVAC industries.

For more detailed information regarding recommended courses for this concentration, visit the Thermal and Fluid Sciences Concentration at the Department of Mechanical Engineering and Mechanics site.

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Software Engineering

Advances in information technology have captured the public imagination and had tremendous economic and social impact over the last 50 years. These advances offer great benefit, but have also created a great need for highly dependable systems developed at predictable cost. Unfortunately, it has become increasingly clear that our ability to produce the software for these systems in a way that meets cost and quality requirements is quite limited.

For example:

- Studies conclude that cost and schedule overruns on commercial software projects commonly average at least 100%. Some studies report averages as high as 300 - 400%.
- Studies of large projects indicate that about 25% of them are abandoned and never completed.
- There is a growing list of incidents in which software failures have caused injury and death.

Software engineering is an attempt to solve this problem. The notion can be traced to a conference sponsored by NATO in 1967. The conference was organized to discuss the problems in creating software systems reliably. In the years since, there has been some progress, but the problems that motivated the original conference are still very much in evidence. There is good reason to believe that the creation of software will never be easy. But there is tremendous incentive to make the process as efficient and reliable as possible.

In summary, software engineering can be defined as the application of processes, methods, and tools to the problem of building and maintaining computer software with a defined level of quality, at a predictable cost, on a predictable schedule.

Software Engineering

Bachelor of Science in Software Engineering (BSSE): 188.0 credits

Degree Requirements

Software engineering requirements		36.0 Credits
SE 101	Foundations of Software Engineering I	3.0
SE 102	Foundations of Software Engineering II	3.0
SE 103	Foundations of Software Engineering III	3.0
SE 210	Software Specification and Design I	3.0
SE 211	Software Specification and Design II	3.0
SE 310	Software Architecture I	3.0
SE 311	Software Architecture II	3.0
SE 320	Sofware Verification and Validation	3.0
SE 410	Software Evolution	3.0
SE 491	Design Project I	3.0
SE 492	Design Project II	3.0
SE 493	Design Project III	3.0

Computer science requirements		16.0 - 17.0 Credits
CS 260	Data Structures	3.0
CS 265	Advanced Programming Techniques	3.0
CS 281	Systems Architecture I	4.0
CS 361	Concurrent Programming	3.0
CS 472	Computer Networks	3.0
or		
INFO 330	Computer Networking Technology I	4.0

Information systems requirements		9.0 Credits
INFO 210	Database Management Systems	3.0
INFO 310	Human Computer Interaction II	3.0
INFO 420 WI	Software Project Management	3.0

Computing electives	18.0 Credits

	Any non-required INFO, CS or SE course at the 300+ level	18.0

Mathematics/statistics requirements		**26.0 Credits**
CS 270	**Mathematical Foundations of Computer Science**	3.0
STAT 201	**Statistics I**	4.0
STAT 202	**Statistics II**	4.0
MATH 121	**Calculus I**	4.0
MATH 122	**Calculus II**	4.0
MATH 123	**Calculus III**	4.0
MATH 221	**Discrete Mathematics**	3.0

Basic Science requirements (Choose one of the following sequences)		**21.0 Credits**
BIO 102	**Biology I: Cells and Tissues**	4.0
BIO 104	**Biology I: Growth and Heredity**	4.0
BIO 106	**Organismal Biology**	4.0
or		
CHEM 101	**General Chemistry I**	3.5
CHEM 102	**General Chemistry II**	4.5
CHEM 103	**General Chemistry III**	5.0
or		
PHYS 111	**Physics I**	4.5
PHYS 112	**Physics II**	4.5
PHYS 211	**Physics III**	4.5
	Additional science electives	7.5 - 9.0

Liberal studies requirements		**33.0 Credits**
ENGL 101	**Expository Writing and Reading**	3.0
ENGL 102	**Persuasive Writing and Reading**	3.0
ENGL 103	**Analytical Writing and Reading**	3.0
PHIL 105	**Critical Reasoning**	3.0
PHIL 311	**Computer Ethics**	3.0
COM 230	**Techniques of Speaking**	3.0
COM 310 WI	**Technical Communication**	3.0
PSY 101	**General Psychology**	3.0
PSY 330	**Cognitive Psychology**	3.0
	Additional liberal studies electives	6.0

Students select two of the following business courses:		**8.0 Credits**
ACCT 115	**Financial Accounting Foundations**	4.0
ECON 201	**Economics I**	4.0
ECON 202	**Economics II**	4.0

University and college requirements		20.0 -21.0 Credits
UNIV 101	**The Drexel Experience ***	2.0
	Free electives	18.0-19.0

*First-term external transfer students are required to take INFO 120 Seminar for Transfer students instead of UNIV 101.

Writing-Intensive Course Requirements
In order to graduate, all students beginning with the entering class of 2002/01 (fall, 2002) must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog indicates that this course can fulfill a writing-intensive requirement. Departments will designate specific sections of such courses as writing-intensive. Sections of writing-intensive courses are not indicated in this catalog. Students should check the section comments in Banner when registering. Students scheduling their courses in Banner can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term. For more information on writing-intensive courses, see the Drexel University Writing Program's Writing-Intensive Course page.

Recommended Plan Of Study

BS Software Engineering
5 YR UG Co-op Concentration

Term 1		Credits
COOP 101	Career Management/Professional Development	0.0
ENGL 101	Expository Writing and Reading	3.0
MATH 121	Calculus I	4.0
SE 101	Foundations of Software Engineering I	3.0
UNIV 101	The Drexel Experience	1.0
BIO 102	Biology I: Cells and Tissues	4.0
or		
CHEM 101	General Chemistry I	4.0
or		
PHYS 111	Physics I	4.5
	Term Credits	*15.0*

Term 2		Credits
ENGL 102	Persuasive Writing and Reading	3.0
MATH 122	Calculus II	4.0
SE 102	Foundations of Software Engineering II	3.0
UNIV 101	The Drexel Experience	0.5
BIO 104	Biology II: Growth and Heredity	4.0
or		
CHEM 102	General Chemistry II	4.0
or		
PHYS 112	Physics II	4.5
	Term Credits	*14.5*

Term 3		Credits
ENGL 103	Analytical Writing and Reading	3.0
MATH 200	Multivariate Calculus	4.0
SE 103	Foundations of Software Engineering III	3.0
UNIV 101	The Drexel Experience	0.5
BIO 106	Biology III: Organismal Biology	4.0
or		
CHEM 103	General Chemistry III	5.0
or		
PHYS 211	Physics III	4.5
	Liberal studies elective	3.0
	Term Credits	*17.5*

Term 4		Credits
COM 230	Techniques of Speaking	3.0
SE 210	Software Specification and Design I	3.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
	Natural Science elective	3.0
	Term Credits	*15.0*

Term 5		Credits
CS 260	Data Structures	3.0
INFO 210	Database Management Systems	3.0
MATH 221	Discrete Mathematics	3.0
SE 211	Software Specification and Design II	3.0
	Natural Science elective	3.0

	Term Credits	*15.0*

Term 6		Credits
COM 310	Technical Communication	3.0
CS 281	Systems Architecture I	4.0
PSY 101	General Psychology I	3.0
SE 310	Software Architecture I	3.0
STAT 201	Business Statistics I	4.0
	Term Credits	*17.0*

Term 7		Credits
SE 311	Software Architecture II	3.0
STAT 202	Business Statistics II	4.0
	Free elective	3.0
	Computing elective (300-level or higher INFO, SE, CS)	3.0
	Natural Science elective	3.0
	Term Credits	*16.0*

Term 8		Credits
CS 361	Concurrent Programming	3.0
INFO 420	Software Project Management	3.0
PHIL 105	Critical Reasoning	3.0
SE 320	Software Verification and Validation	3.0
	Free elective	3.0
	Term Credits	*15.0*

Term 9		Credits
INFO 310	Human-Computer Interaction II	3.0
PHIL 311	Computer Ethics	3.0
SE 410	Software Evolution	3.0
	Computing electives (300-level or higher INFO, SE, CS)	3.0
	Free elective	3.0
	Term Credits	*15.0*

Term 10		Credits
SE 491	Design Project I	3.0
CS 472	Computer Networks	3.0
or		
INFO 330	Computer Networking Technologies I	4.0
ACCT 115	Financial Accounting Foundations	4.0
or		
ECON 201	Economics I	4.0
or		
ECON 202	Economics II	4.0
	Computing elective (300-level or higher INFO, SE, CS)	3.0
	Free elective	3.0
	Term Credits	*16.0*

Term 11		Credits
PSY 330	Cognitive Psychology	3.0
SE 492	Design Project II	3.0
ACCT 115	Financial Accounting Foundations	4.0
or		
ECON 201	Economics I	4.0
or		
ECON 202	Economics II	4.0
	Computing electives (300-level or higher INFO, SE, CS)	6.0
	Term Credits	*16.0*

Term 12		Credits
SE 493	Design Project III	3.0
	Computing elective (300-level or higher INFO, SE, CS)	3.0
	Free electives	7.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Minor in Software Engineering

The software engineering minor is available to all University students in good standing, with the exception of software engineering majors. A total of 24 credits is needed to complete the academic minor in software engineering.

Requirements		Credits
SE 210	**Software Specification and Design I**	3.0
SE 211	**Software Specification and Design II**	3.0
SE 310	**Software Architecture I**	3.0
SE 311	**Software Architecture II**	3.0
SE 320	**Sofware Verification and Validation**	3.0
SE 410	**Software Evolution**	3.0
	Two Computing/Software Engineering electives	6.0