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The College of Engineering Undergraduate Programs

Drexel University

Catalog 2006 / 2007

The College of Engineering

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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0

TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

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. Five of the 10 courses are designated as follows and must be completed by all majors:

Designated liberal studies course requirements

HIST 285	**Technology in Historical Perspective**	
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**	

The five 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. The acceptable economics courses for engineering majors are ECON 211/212 (Principles of Economics I and II) and ECON 201/202 (Economics I and II).

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.

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

- Provide students with a solid scientific and mathematical foundation, knowledge of engineering principles and their application to the solution of problems, and a sense of engineering judgment, which comprise the technical competencies necessary to plan, design, construct, operate, and maintain large-scale building systems and structures
- Develop an awareness of mitigating adverse impacts of projects on the social, economic, and natural environments locally, regionally, and globally
- Prepare students for professional practice through preparation for professional licensing, development of ethical judgment, and appreciation of lifelong learning and graduate and other advanced study
- Provide experience in and develop proficiency for working in multidisciplinary teams; working with the public; and acquiring necessary

oral, writing, and graphical communication skills

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

Required courses

General education requirements		Credits
ECON 211	**Principles of Economics I (Micro)**	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
UNIV 101	**The Drexel Experience**	2.0
	Liberal studies electives	9.0
	Free elective	3.0

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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

Major requirements

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 370	**Introduction to Structural Analysis**	3.0
CIVE 371	**Structural Design**	3.0
CIVE 320	**Fundamentals of Fluid Flow**	3.0
CIVE 372	**Structural Laboratory**	1.0
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

AE 430	**Control Systems for HVAC**	3.0
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

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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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
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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 123	Calculus III	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
CAEE 201	Introduction to Infrastructure Engineering	3.0
PHYS 201	Fundamentals of Physics III	4.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
	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
MEM 202	Engineering Mechanics-Statics	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*19.0*

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 370	Introduction to Structural Analysis	3.0
MATH 201	Linear Algebra	4.0
or		
MATH 290	Linear Modeling for Engineers	4.0
	Liberal studies elective	3.0
	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
MEM 345	Heat Transfer	4.0
	Term Credits	*12.0*

Term 10		Credits
AE 544	Building Envelope Systems	3.0
CAE 491	Senior Design Project I	3.0
CIVE 240	Engineering Economic Analysis	3.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
MEM 413	HVAC Loads	3.0
	Liberal studies elective	3.0
	Term Credits	*18.0*

Term 11		Credits
CAE 492	Senior Design Project II	3.0
MEM 414	HVAC Equipment	3.0
	Liberal studies elective	3.0
	Professional electives (See degree requirements for list)	6.0
	Term Credits	*15.0*

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 electives (See degree requirements for list)	6.0
	Term Credits	*15.0*

	Total Credits (minimum)	200.0

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Recommended Plan Of Study

BS Architectural Engineering

5 YR UG Co-op Concentration /Structural

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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 123	Calculus III	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
PHYS 201	Fundamentals of Physics III	4.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	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
MEM 202	Engineering Mechanics-Statics	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*19.0*

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 300	Theory of Structures I	3.0
CIVE 310	Soil Mechanics I	4.0
MATH 201	Linear Algebra	4.0
or		
MATH 290	Linear Modeling for Engineers	4.0
	Term Credits	*18.0*

Term 9		Credits
AE 391	Architectural Engineering Design II	4.0
CIVE 301	Theory of Structures II	4.0
	Liberal studies electives	6.0
	Term Credits	*14.0*

Term 10		Credits
AE 544	Building Envelope Systems	3.0
CAE 491	Senior Design Project I	3.0
CIVE 240	Engineering Economic Analysis	3.0
CIVE 400	Structural Design I	3.0
ENGR 361	Statistical Analysis of Engineering Systems	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
	Professional elective (See degree requirements for list)	3.0
	Term Credits	*15.0*

Term 12		Credits
CAE 493	Senior Design Project III	3.0
CIVE 402	Structural Design III	3.0
	Liberal studies elective	3.0
	Professional electives (See degree requirements for list)	6.0
	Term Credits	*15.0*

	Total Credits (minimum)	200.0

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	6.0

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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0

TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

Professional requirements		**Credits**
CHE 201	**Process Material Balances**	3.0
CHE 202	**Process Energy Balances**	3.0
CHE 250	**Chemical Engineering Process Principles**	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.

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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

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Recommended Plan Of Study

BS Chemical Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
CHE 201	Process Material Balances	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
CHE 202	Process Energy Balances	3.0
CHE 250	Chemical Engineering Process Principles	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*16.0*

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
	Free electives	6.0
	Term Credits	*16.0*

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)	194.5

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

- *Provide students with a solid scientific and mathematical foundation, knowledge of engineering principles and their application to the solution of problems, and a sense of engineering judgment, which comprise the technical competencies necessary to plan, design, construct, operate, and maintain large-scale infrastructure, environmental, and natural resource systems and structures*
- *Develop an awareness of mitigating adverse impacts of projects on the social, economic, and natural environments locally, regionally and globally*
- *Prepare students for professional practice through preparation for professional licensing, development of ethical judgment, and appreciation of lifelong learning and graduate and other advanced study*

- *Provide experience in and develop proficiency for working in multidisciplinary teams; working with the public; and acquiring necessary oral, writing, and graphical communication skills*

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: 194.5 credits

General education requirements		Credits
ECON 211	**Principles of Economics I (Micro)**	3.0
ECON 212	**Principles of Economics II (Macro)**	3.0
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
MATH 201	**Linear Algebra**	4.0
ENGR 361	**Statistical Analysis of Engineering Systems**	4.0
UNIV 101	**The Drexel Experience**	2.0
	Liberal studies electives	9.0
	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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0

TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

Major requirements		**Credits**
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	**Engineering Economics**	3.0
CIVE 250	**Construction Materials**	4.0
CIVE 252	**Introduction to Transportation Infrastructure**	3.0
CIVE 370	**Introduction to Structural Analysis**	3.0
CIVE 371	**Introduction to Structural Design**	3.0
CIVE 310	**Soil Mechanics I**	4.0
CIVE 320	**Fundamentals of Fluid Flow**	4.0
CIVE 330	**Hydraulics I**	3.0
CIVE 341	**Municipal Water Facilities**	3.0
CIVE 360	**Water Quality Infrastructure**	3.0
CIVE 375	**In Situ Material Behavior**	3.0
CIVE 420	**Water and Waste Treatment I**	3.0
CIVE 430	**Hydrology**	3.0
CIVE 477 WI	**Seminar I**	2.0
CIVE 478	**Seminar II**	1.0
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.**

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.

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Recommended Plan Of Study

BS Civil Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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
	Term Credits	*18.5*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
PHYS 201	Fundamentals of Physics III	4.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data I	4.0
	Term Credits	*17.0*

Term 5		Credits
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
MEM 202	Engineering Mechanics-Statics	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*16.0*

Term 6		Credits
CIVE 240	Engineering Economic Analysis	3.0
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
MEM 230	Mechanics of Materials I	4.0
	Term Credits	*17.0*

Term 7		Credits
CAEE 211	Measurements in Civil, Architectural and Environmental Engineering II	4.0
CIVE 250	Construction Materials	4.0
CIVE 330	Hydraulics	3.0
	Liberal studies elective	3.0
	Term Credits	*14.0*

Term 8		Credits
CIVE 310	Soil Mechanics I	4.0
CIVE 370	Introduction to Structural Analysis	3.0
CIVE 372	Structural Laboratory	1.0
CIVE 375	Structural Material Behavior	3.0
CIVE 430	Hydrology	3.0
MATH 201	Linear Algebra	4.0
or		
MATH 290	Linear Modeling for Engineers	4.0
	Liberal studies elective	3.0
	Term Credits	*21.0*

Term 9		Credits
CIVE 371	Introduction to Structural Design	3.0
CIVE 410	Foundation Engineering	3.0
	Liberal studies electives	6.0
	Term Credits	*12.0*

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)	194.5

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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ECE 200	**Fundamentals of Intelligent Systems**	3.0
ECE 201	**Foundations of Electric Circuits**	3.0
ECE 203	**Programming for Engineers**	3.0
TDEC 201	**Energy I**	3.0

TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

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 290	**Linear Modeling for Engineers**	4.0
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

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Writing Program's Writing-Intensive Course page.

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Recommended Plan Of Study

BS Computer Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
ECE 200	Fundamentals of Intelligent Systems	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*16.0*

Term 6		Credits
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
MATH 221	Discrete Mathematics	3.0
PHIL 315	Engineering Ethics	3.0
	Term Credits	*19.0*

Term 8		Credits
ENGR 361	Statistical Analysis of Engineering Systems	3.0
ECEC 355	Computer Structures	4.0
ECEL 303	ECE Laboratory III	2.0
	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
	Free elective	3.0
	Liberal studies elective	3.0
	Term Credits	*17.0-18.0*

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)	194.5-197.5

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, 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 has been accredited by the Computing Accreditation Commision (CAC) of the Accreditation Board of Engineering and Technology (ABET) since 1986. Accreditation of the B.A. program will be sought as soon as the program is eligible.

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.

Specific Objectives:

- For students to understand and be able to apply the underlying principles of Computer Science to a variety of problem domains.
- To develop stong analytical skills and good communication skills so that students can quickly assess how to solve problems and communicate their solution. To be able to work in groups and appreciate the dynamic and collaborative nature of problem solving.
- To equip students with a thorough understanding of the development process of software including design, implementation, documentation, and testing.
- To provide students with the skills to keep current in an ever changing technological world.
- To enable students 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.

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

Computer Science

The Department of Computer Science offers both a Bachelor of Science (B.S.) and a Bachelor of Arts (B.A.). Students may choose the program that best fits their needs and future goals.

The Bachelor of Science (B.S.) program emphasizes foundation courses in the sciences and in applied mathematics, leading to careers involving applications in science and engineering.

The Bachelor of Arts (B.A) program emphasizes foundation courses in the humanities and the social sciences, leading to careers involving applications in those areas.

The Bachelor of Science (B.S.) Degree Requirements

The Bachelor of Arts (B.A) Degree Requirements

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 452 WI	**Software Engineering Workshop I**	3.0
CS 453 WI	**Software Engineering Workshop II**	3.0
CS 480	**Special Topics in CS: Introduction to Software Engineering Workshop**	3.0
ECE 200	**Fundamentals of Intelligent Systems**	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 480	**Special Topics in CS: 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

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. 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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Recommended Plan Of Study

BS Computer Science
5 YR UG Co-op Concentration

Term 1		Credits
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	1.0
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	*18.0*

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 123	Calculus III	4.0
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	*17.0*

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	Fundamentals of Intelligent Systems	3.0
MATH 221	Discrete Mathematics	3.0
	Business elective	3.0

	Science elective	3.0
	Term Credits	*15.0*

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
	Writing/Communication elective (See approved course list)	3.0
	Term Credits	*16.0*

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
	General education elective	3.0
	Term Credits	*13.0*

Term 10		Credits
CS 480	Special Topics in Computer Science: Introduction to Sofware 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 452	Software Engineering Workshop I	3.0
	Computer science electives (See degree requirements)	6.0
	Free elective	3.0
	General education elective	3.0
	Term Credits	*15.0*

Term 12		Credits
CS 453	Software Engineering Workshop II	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)	186.5-187.5

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		66.0 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 480	Special Topics in CS: Introduction to Software Engineering Workshop	3.0
CS 452 WI	Software Engineering Workshop I	3.0
CS 453 WI	Software Engineering Workshop II	3.0
ECE 200	Fundamentals of Intelligent Systems	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 480	**Special Topics in CS: 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
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. 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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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	1.0
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	*15.0*

Term 3		Credits
CS 172	Computer Programming II	3.0
ENGL 103	Analytical Writing and Reading	3.0
MATH 239	Intermediate Calculus	4.0
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	*17.0*

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	Fundamentals of Intelligent Systems	3.0
MATH 221	Discrete Mathematics	3.0
	Science elective	4.0
	Social science elective	3.0
	Term Credits	*16.0*

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
CS 451	Software Engineering	3.0
PHIL 311	Computer Ethics	3.0
	Computer Science elective (See degree requirements for list)	3.0
	Free elective	3.0
	Foreign language course	3.0
	Term Credits	*15.0*

Term 9		Credits
	Computer science electives (See degree requirements)	6.0
	Diversity studies elective	3.0
	Free elective	3.0
	Foreign language course	4.0
	Term Credits	*16.0*

Term 10		Credits
CS 480	Special Topics in CS: Introduction to Software Engineering Workship	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 452	Software Engineering Workshop I	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 453	Software Engineering Workshop II	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

Drexel University

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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

Top

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	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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
ECE 200	**Fundamentals of Intelligent Systems**	3.0
ECE 201	**Foundations of Electric Circuits**	3.0
ECE 203	**Programming for Engineers**	3.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0

TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

Professional requirements		**Credits**
ECE 491	**Senior Project Design I**	2.0
ECE 492	**SeniorProject 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 290	**Linear Modeling for Engineers**	4.0
MATH 291	**Complex and Vector Analysis for Engineers**	4.0
	Additional interdisciplinary courses (1)	3.0
	ECE track courses (8)	32.0
	Electrical engineering senior sequence	9.0-12.0
	ECE technical electives	9.0-12.0
	Free electives	0.0-6.0

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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Recommended Plan Of Study

BS Electrical Engineering

5 YR UG Co-op Concentration /Telecommunications/DSP

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

Term 2		Credits
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGL 101	Expository 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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
ECE 200	Fundamentals of Intelligent Systems	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*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
MATH 290	Linear Modeling for Engineers	4.0
	Term Credits	*17.0*

Term 7		Credits

ECEL 302	Electrical Engineering Laboratory II	2.0
ECES 352	Digital Signal Processing	4.0
MATH 291	Complex and Vector Analysis for Engineering	4.0
PHIL 315	Engineering Ethics	3.0
	ECE Core elective 300-level (See degree requirements)	4.0
	Term Credits	*17.0*

Term 8		Credits
ECEE 304	Electromagnetic Fields and Waves	4.0
ECEL 303	Electrical Engineering Laboratory III	2.0
ECES 306	Modulation and Coding	4.0
ENGR 361	Statistical Analysis of Engineering	3.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 9		Credits
ECEE 354	Wireless and Optical Electronics	4.0
ECEL 304	Electrical Engineering Laboratory IV	2.0
	ECE Core elective 300-level (See degree requirements)	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 421	Communications I	3.0
or		
ECES 434	Discrete Time Systems	4.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Free elective	3.5
	Liberal studies elective	3.0
	Term Credits	*14.5-15.5*

Term 11		Credits
ECE 492	Senior Design II	2.0
ECES 422	Communications II	3.0
or		
ECES 435	Statistical Signal Processing	4.0
	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
ECES 423	Communications III	3.0
or		
ECES 436	Speech and Image Signal Processing	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)	192.0-195.0

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Recommended Plan Of Study

BS Electrical Engineering

5 YR UG Co-op Concentration /Electronics

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
ECE 200	Fundamentals of Intelligent Systems	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*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
MATH 290	Linear Modeling for Engineers	4.0
	Term Credits	*17.0*

Term 7		Credits

ECEE 352	Analog Electronics	4.0
ECEL 302	ECE Laboratory II	2.0
MATH 291	Complex and Vector Analysis for Engineers	4.0
PHIL 315	Engineering Ethics	3.0
	ECE Core elective 300-level (See degree requirements)	4.0
	Term Credits	*17.0*

Term 8		Credits
ECEE 304	Electromagnetic Fields and Waves	4.0
ECEL 303	ECE Laboratory III	2.0
ENGR 361	Statistical Analysis of Engineering Systems	3.0
	ECE Core elective 300-level (See degree requirements)	4.0
	Liberal studies elective	3.0
	Term Credits	*16.0*

Term 9		Credits
ECEE 354	Wireless and Optical Electronics	4.0
ECEL 304	Electrical Engineering Laboratory IV	2.0
	ECE Core elective 300-level (See degree requirements)	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
ECEE 421	Advanced Electronics I	4.0
or		
ECEE 471	RF Components and Techniques	4.0
	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
ECEE 422	Advanced Electronic Circuits I	3.0
or		
ECEE 472	RF Electronics	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	*13.5-14.5*

Term 12		Credits
ECE 493	Senior Design III	4.0
ECEE 433	Advanced Electronics III	3.0
or		
ECEE 473	Antennas and Radiating Systms	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)	192.0-195.0

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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
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
ECE 200	Fundamentals of Intelligent Systems	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
ECE 201	Foundations of Electric Circuits	3.0
ECE 203	Programming for Engineers	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*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
MATH 290	Linear Modeling for Engineers	4.0
	Term Credits	*17.0*

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 (See degree requirements)	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 (See degree requirements)	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 (See degree requirements)	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
ECEP 411	Power Systems I	3.0
or		
ECES 444	Systems and Control I	4.0
	ECE Technical elective (300 or 400-level ECE course)	3.0-4.0
	Free elective	3.5
	Liberal studies elective	3.0
	Term Credits	*14.5-15.5*

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
	Liberal studies elective	3.0
	Term Credits	*12.0-13.0*

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)	190.0-193.0

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

• To provide students with a knowledge of the fundamentals underlying environmental engineering and the application of this knowledge to problem solving;
• To provide students with the ability to integrate knowledge from diverse sources, develop new knowledge, and apply that knowledge to environmental problem solving;
• To provide students with the abiliity to interact with others in the identification and solution of environmental problems;
• To provide students with a knowledge of the scientific, technological, economic, ethical, social and cultural contexts of environmental problems; and
• To provide students with the skills necessary to lead others in the resolution of environmental problems.

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
ECON 211	**Principles of Economics I (Micro)**	3.0
ECON 212	**Principles of Economics II (Macro)**	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
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	9.0

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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0

TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

Environmental engineering requirements		**Credits**
BIO 221	**Microbiology**	5.0
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
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

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.

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Recommended Plan Of Study

BS Environmental Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

Term 2		Credits
UNIV 101	The Drexel Experience	1.0
ENGL 102	Persuasive Writing and Reading	3.0
CHEM 102	General Chemistry II	4.5
CS 122	Computation Lab II	1.0
ENGR 102	Engineering Design Laboratory II	2.0
MATH 122	Calculus II	4.0
PHYS 101	Fundamentals of Physics I	4.0
	Term Credits	*19.5*

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
ENGL 103	Analytical Writing and Reading	3.0
	Term Credits	*18.5*

Term 4		Credits
CAEE 201	Introduction to Infrastructure Engineering	3.0
PHYS 201	Fundamentals of Physics III	4.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*17.0*

Term 5		Credits
CAEE 210	Measurements in Civil, Architectural and Environmental Engineering I	3.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
BIO 221	Microbiology	5.0
or		
ENVR 284	Ecology I: Physiological and Population Ecology	5.0
	Term Credits	*18.0*

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
	Free 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
	Free 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
	Free elective	3.0
	Term Credits	*15.0*

	Total Credits (minimum)	198.5

Materials Engineering

Materials engineering is concerned with the production, properties, and utilization of metals, ceramics, polymers, composites, and electronic materials. Materials engineers play a vital 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 cost, reliability, safety, and social/environmental implications.

Students majoring in materials engineering get 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 for characterizing materials and evaluating their performance. In addition, several required senior courses emphasize the role of materials 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
Our mission is to produce graduates who can excel in leadership positions in industry and academia at the national and international levels.

Program Objectives

- *Educate our students so that they possess the technical competencies required to interface with all engineering disciplines in the workplace*
- *Increase the number of materials engineering graduates who have the aptitude for postgraduate education at the nation's premier engineering institutions or professional schools, and who could become leaders in their chosen fields*
- *Enhance the skills of our undergraduates in experimental methods and modeling, with a focus on materials engineering*
- *Develop an ability in our students to successfully undertake lifelong learning in the discipline and practice of materials engineering or in any other profession*
- *Enhance the verbal and written communication skills of materials engineering students*

Senior Design Projects
Throughout the senior year, majors in materials engineering work on a capstone senior design project with guidance from a faculty advisor. Students, working in small groups, synthesize information from their

courses to arrive at solutions to real-world engineering problems. Some current senior design projects include:

- Material for an Artificial Muscle
- Polymeric Nanofibers for Use in Batteries
- Ceramic Powders for Use in Filtering Applications
- Design of an Esophagus Dilator for the Body

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

Foundation requirements

CHE 310	**Transport Phenomena**	4.0
CHEC 353	**Physical Chemistry and Applications III**	4.0
CHEM 241	**Organic Chemistry I**	4.0
MATH 201	**Linear Algebra**	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
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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0

TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0
TDEC 211	**Materials I**	3.0
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0
TDEC 231	**Evaluation/Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation/Presentation of Experimental Data II**	4.0

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 367	**Microstructure of Metallic Materials**	4.0
MATE 366 WI	**Processing of Metallic Materials**	4.5
MATE 370	**Mechanical Behavior of Solids**	3.0
MATE 400	**Materials Engineering Design ***	3.0
MATE 410	**Case Studies in Materials**	3.0
MATE 455	**Biomedical Materials**	3.0
MATE 458	**Advanced Biomaterials**	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

* Check with department for possible alternative.

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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Recommended Plan Of Study

BS Materials Engineering
5 YR UG Co-op Concentration

Term 1		Credits
CHEM 101	General Chemistry I	3.5
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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
	Term Credits	*18.5*

Term 4		Credits
CHEM 241	Organic Chemistry I	4.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation & Presentation of Experimental Data	4.0
	Term Credits	*17.0*

Term 5		Credits
MATE 221	Introduction to Mechanical Behavior of Materials	3.0
MATH 201	Linear Algebra	4.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation & Presentation of Experimental Data II	4.0
	Term Credits	*17.0*

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 367	Microstructure 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
MATE 458	Advanced Biomaterials	3.0
PHIL 315	Engineering Ethics	3.0
	Term Credits	*17.5*

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
MATE 400	Materials Engineering Design	3.0
	Term Credits	*19.0*

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
MATE 460	Engineering Computational Laboratory	4.0
MATE 491	Senior Design I	2.0
PHYS 451	Quantum Structure of Materials	4.0
	Liberal studies elective	3.0
	Term Credits	*13.0*

Term 11		Credits
MATE 410	Case Studies in Materials	3.0
MATE 492	Senior Design II	2.0
	Liberal studies elective	3.0
	Technical elective	3.0
	Term Credits	*11.0*

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)	195.0

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 e 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

- *Deliver a comprehensive mechanical engineering curriculum which emphasizes both the foundations and breadth of the mechanical engineering profession*
- *Provide an education that equips students with the tools necessary to become successful mechanical engineers based on their co-op experience, strong communication skills, and awareness of the need for continuous professional development*
- *Provide an education that will allow mechanical engineering students to understand the social, economic, environmental, political, and ethical importance of their future profession*
- *Provide mechanical engineering students with a thorough understanding of the impact of mechanical engineers and the mechanical engineering profession in the development, implementation and creation of future technology.*

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
TDEC 221	**Systems I**	3.0
TDEC 222	**Systems II**	3.0

Physics requirements

PHYS 101	**Fundamentals of Physics I**	4.0
PHYS 102	**Fundamentals of Physics II**	4.0
TDEC 201	**Energy I**	3.0
TDEC 202	**Energy II**	3.0

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 101	**Engineering Design Laboratory I**	2.0
ENGR 102	**Engineering Design Laboratory II**	2.0
ENGR 103	**Engineering Design Laboratory III**	2.0
TDEC 231	**Evaluation and Presentation of Experimental Data I**	4.0
TDEC 232	**Evaluation and Presentation of Experimental Data II**	4.0

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

TDEC 211	**Materials I**	3.0

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 311	**Thermal Fluid Science Laboratory**	2.0
MEM 331	**Experimental Mechanics Laboratory**	2.0
MEM 351	**Dynamic Systems Laboratory**	2.0
MEM 310	**Thermodynamic Analysis I**	4.0
MEM 345	**Heat Transfer**	4.0
MEM 355	**Performance Enhancement of Dynamic Systems**	4.0
MEM 361	**Engineering Reliability**	3.0
MEM 465	**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 designated electives*	12.0
	MEM undesignated electives*	6.0
	MEM/CoE electives**	6.0
	MEM/Science/technical electives***	6.0
	Free electives	6.0

* All MEM students must complete a minimum of four of the advanced MEM fundamentals courses, plus any other two MEM courses 300 level or higher.

** Any MEM or College of Engineering course 300 level or higher.

*** Any MEM or science/engineering course 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 423	**Mechanics of Vibration**	4.0
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

Mechanical Engineering

Recommended Plan of Study:

B.S. in Mechanical Engineering

Areas of Concentration
Because of the diversity of mechanical engineering, students are offered the option to concentrate in one of the following areas:

Aerospace
Biomechanical Engineering
Design and Manufacturing
Mechanics and Structures
Systems and Control
Thermal and Fluid Sciences

This option is typically available starting Term 8 (Fall or Spring term in the Junior year). Although not required, students who have opted to take such concentrations will find it extremely beneficial to pursue their Senior Design projects within the corresponding concentration.

The department suggests that students take at least six courses within their concentration, with the exception of Biomechanical Engineering and Design and Manufacturing (these concentrations require specific courses, a senior design project and a suggested co-op experience).

Students should consult the undergraduate advisor and the coordinating faculty of the respective concentration area to select their electives and to complete the Plan of Study based on the courses listed in the concentration pages.

For more detailed information regarding these areas of concentration, visit the Areas of Concentration page at the Department of Mechanical Engineering and Mechanics site.

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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
CS 121	Computation Lab I	1.0
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
	Term Credits	*14.5*

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	1.0
	Term Credits	*19.5*

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	Calculus IV	4.0
PHYS 102	Fundamentals of Physics II	4.0
	Term Credits	*18.5*

Term 4		Credits
MEM 202	Engineering Mechanics: Statics	3.0
TDEC 201	Energy I	3.0
TDEC 211	Materials I	3.0
TDEC 221	Systems I	3.0
TDEC 231	Evaluation/Presentation of Experimental Data	4.0
	Term Credits	*16.0*

Term 5		Credits
MEM 201	Fundamentals of Computer-Aided Design	3.0
MEM 230	Mechanics of Materials I	4.0
TDEC 202	Energy II	3.0
TDEC 222	Systems II	3.0
TDEC 232	Evaluation/Presentation of Experimental Data II	4.0
	Term Credits	*17.0*

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 310	Thermal Analysis	4.0
MEM 238	Engineering Mechanics: Dynamic	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 345	Heat Transfer	4.0
MEM 435	Introduction to CAD/CAM	4.0
MEM 330	Mechanics of Materials II	4.0
or		
MEM 410	Thermodynamic Analysis II	3.0
	MEM course (see degree requirements list for options)	3.0
	Term Credits	*21.0*

Term 9		Credits
MEM 351	Dynamic Systems Laboratory	2.0
MEM 361	Engineering Reliability	3.0
MEM 320	Fluid Dynamics I	3.0
or		
MEM 423	Mechanics of Vibrations	4.0
or		
MEM 440	Thermal Systems Analysis	3.0
or		
MEM 458	Microcomputer-Based Control Systems I	3.0
	Liberal studies elective	3.0-4.0
	Two MEM courses (see degree requirements list for options)	8.0
	Term Credits	*19.0-20.0*

Term 10		Credits
MEM 491	Senior Design I	3.0
MEM 440	Thermal Systems Analysis	3.0
or		
MEM 320	Fluid Dynamics I	3.0
or		
MEM 423	Mechanics of Vibrations	4.0
	Liberal studies elective	3.0-4.0
	MEM course (see degree requirements list for options)	3.0
	Any 300-level or higher MEM elective	3.0-4.0
	MEM/science/technical elective	3.0-4.0
	Term Credits	*18.0-21.0*

Term 11		Credits
MEM 492	Senior Design II	3.0
	Free electives	6.0
	Liberal studies elective	3.0-4.0
	Any 300-level or higher MEM elective	3.0-4.0
	MEM/science/technical elective	3.0-4.0
	Term Credits	*18.0-21.0*

Term 12		Credits
MEM 493	Senior Project Design III	3.0
	Liberal studies elective	3.0-4.0
	Any 300-level or higher MEM elective	3.0-4.0
	Term Credits	*9.0-11.0*

	Total Credits (minimum)	204.5-213.5

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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 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): 192.0 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**	2.0
SE 492	**Design Project II**	2.0
SE 493	**Design Project III**	4.0

Computer science requirements		15.0 - 16.0 Credits
CS 260	**Data Structures**	3.0
CS 265	**Advanced Programming Techniques**	3.0
CS 281	**Systems Architecture I**	3.0
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

Computer engineering requirements		3.0 Credits

ECE 200	**Fundamentals of Intelligent Systems**	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**
STAT 201	**Statistics I**	4.0
STAT 202	**Statistics II**	4.0
CS 270	**Mathematical Foundations of Computer Science**	3.0
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		**25.0 - 26.0 Credits**
UNIV 101	**The Drexel Experience ***	2.0
	Free electives	23.0-24.0

*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.

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Recommended Plan Of Study

BS Software Engineering
5 YR UG Co-op Concentration

Term 1		Credits
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	1.0
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	*15.0*

Term 3		Credits
ENGL 103	Analytical Writing and Reading	3.0
MATH 123	Calculus III	4.0
SE 103	Foundations of Software Engineering III	3.0
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	*17.0*

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
SE 320	Software Verification and Validation	3.0
	Free elective	3.0
	Term Credits	*12.0*

Term 9		Credits
INFO 310	Human-Computer Interaction II	3.0
PHIL 105	Critical Reasoning	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	2.0
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	*15.0*

Term 11		Credits
PSY 330	Cognitive Psychology	3.0
SE 492	Design Project II	2.0
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	*15.0*

Term 12		Credits
PHIL 311	Computer Ethics	3.0
SE 493	Design Project III	4.0
	Free electives	5.0
	Liberal studies elective	3.0
	Term Credits	*15.0*

	Total Credits (minimum)	182.0

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 tDEC 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**
AE 210	**Introduction to AE Building Systems**	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

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. Calculus prerequisites should include TDEC 110, 112, and 114 or MATH 121-123 and 200. Physics requirements are TDEC 111, 113, and 115, or PHYS 111, 112, and 211. 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	**Fundamentals of Intelligent Systems**	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.

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 TDEC curriculum. In mathematics, this would cover calculus (TDEC 110, 112, and 114 or MATH 121-123 and 200) and differential equations (TDEC 221 and 222, or MATH 210). Knowledge of linear algebra is also recommended. Physics requirements are TDEC 111, 113, and 115, or PHYS 111, 112, and 211. Courses taken to meet these requirements will not count toward the minor.

Required courses		**14.0 Credits**
ECE 200	**Fundamentals of Intelligent Systems**	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.

Minor in Engineering Management

The minor in engineering management focuses on the management of technical organizations and projects. The core courses cover entrepreneurship and the development of new technology products and projects.

The student's selection of electives are from a large list of multi-disciplinary engineering and non-engineering courses. This enables students to tailor the elective cycle to their professional development interests. The Engineering Management Program will permit reasonable latitude for students to suggest additional courses for inclusion based on stated professional development goals.

While this minor is primarily designed to provide engineering management knowledge and skills to other engineers, with the equivalent science background students from other sciences can also complete this minor.

The minor consists of a minimum of 24 credits total, with five required core courses. Students select three additional elective courses approved by the department.

Prerequisites
The tDEC 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		**15.0 Credits**
CIVE 240 WI	**Engineering Economics**	3.0
MEM 462 WI	**Introduction to Engineering Management**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Technical Development for Engineers**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Introduction to Entrepreneurial Engineering**	3.0
MEM 380	**Special Topics in Mechanical Engineering: Introduction to Project Management for Engineers**	3.0

Students select a minimum of three additional elective courses. The following list provides suggested electives. Based on individual professional development goals, students may request departmental approval for other electives not included in this list:

CIVE 446	**Contract Specifications and Engineering Law**	3.0
CHE 335	**Statistics and Design of Experiments**	3.0
CHE 451	**Safety Engineering**	3.0
CS 337	**Psychology of Human-Computer Interactions**	3.0
COM 310 WI	**Technical Communication**	3.0
ECEP 354	**Energy Management Principles**	3.0
ENVE 335	**Industrial Safety**	3.0
ENVR 331	**Industrial Hygiene I**	3.0
MEM 361	**Engineering Reliability**	3.0

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 tDEC 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**
ENVE 152	**Environmental Measurement**	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

Minor in Materials Engineering

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

Required courses		Credits
At least 21.0 credits from the following courses		
MATE 214	**Introduction to Polymers**	4.5
MATE 240	**Thermodynamics of MaterialsI**	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

***Taken in the sophomore or pre-junior year.**

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 cited list. Students pursuing the minor are encouraged to select a senior design topic that is relevant to materials.

Minor in Mechanical Engineering

Any undergraduate student in good standing who has completed more than 30 credits at Drexel may apply for the minor in mechanical engineering. The minor must contain a minimum of 24 credits according to the following distribution: (a) 16 credits from any four of the 4-credit required courses; (b) at least eight credits from additional required courses or from the laboratory components and recommended electives.

Required courses		Credits
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 345	**Heat Transfer**	4.0
MEM 355	**Performance Enhancement of Dynamic Systems**	4.0
MEM 361	**Engineering Reliability**	3.0
MEM 465	**Introduction to CAD/CAM**	4.0

Laboratories		
MEM 311	**Thermal Fluid Science Laboratory**	2.0
MEM 331	**Experimental Mechanics Laoratory**	2.0
MEM 351	**Dynamic Systems Laboratory**	2.0

Recommended electives		
MEM 320	**Fluid Dynamics I**	3.0
MEM 330	**Mechanics of Materials II**	4.0
MEM 410	**Thermodynamics Analysis II**	3.0
MEM 420	**Aerodynamics**	3.0
MEM 423	**Mechanics of Vibration**	4.0
MEM 425	**Aircraft Design/Performance**	3.0
MEM 430	**Advanced Stress Analysis**	4.0
MEM 437	**Manufacturing Process I**	3.0
MEM 438	**Manufacturing Process II**	3.0

MEM 440	**Thermal Systems Design**	3.0
MEM 453	**Aircraft Flight Dynamics and Control I**	3.0
MEM 455	**Introduction to Robotics**	3.0
MEM 458	**Microcomputer-Based Control Systems I**	3.0
MEM 459	**Microcomputer-Based Control Systems II**	3.0
MEM 462 WI	**Introduction to Engineering Management**	3.0

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 Software Engineering electives	6.0