Drexel University
Catalog 2009/2010

Table of Contents

The College of Engineering

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The College of Engineering

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

As Drexel moves into the 21st century, the College of Engineering remains the flagship college of the university, offering students a truly diverse academic learning and research environment, while continuing to build on its national reputation for excellence in engineering and research.

The College of Engineering offers graduate degree programs in the following disciplines:

- Biochemical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Sciences
- Electrical Engineering
- Computer Engineering
- Telecommunications Engineering
- Engineering Management
- Environmental Engineering
- Master of Engineering
- Materials Engineering
- Mechanical Engineering and Mechanics

In addition, the College offers a multidisciplinary program in Software Engineering and Engineering Management in concert with other Drexel University colleges.

Graduate Co-op Program (GCP)

Drexel University's long tradition in the field of experiential learning has now been extended into many of its master's programs in science, business, and engineering.

This option, called the Graduate Co-op Program (GCP), provides students with the opportunity to gain work experience directly related to their career goals while earning academic credit. Students who have earned a minimum of 24 credits with a GPA of at least 3.0 are eligible to participate. Employment typically lasts six months, during which students enroll in a special 3 credit GCP course coinciding with their term of employment. Students gain work experience while earning salaries. It is important to note that the GCP program does not guarantee a job. It is a market-driven process for the candidates as well as employers. GCP provides the tools and contacts; the student must qualify for the job on the basis of merit, qualifications, and skills.

Further information on the GCP program is available at the Drexel Steinbright Career Development Center.

Chemical Engineering

The graduate program in the Chemical and Biological Engineering Department integrates current chemical engineering science with the growing fields of engineering applications and processes. In emphasizing engineering design, as well as scientific analysis. The department intends to develop broadly educated individuals who are knowledgeable in modern theories, cognizant of the behavior of engineering systems, and aware of current mathematical and engineering tools that are useful for the solution of problems in complex processes and systems, especially those in the fields of chemical, environmental, biochemical, and materials process engineering. Areas of particular strength include biological engineering, energy and the environment, multiscale modeling and process systems engineering, and polymer science and engineering.

Programs are arranged to meet the needs and interests of individual students. The plan of study is initially formulated in consultation with the departmental graduate advisor and subsequently guided by the thesis advisor.

Graduates have pursued a variety of careers, ranging from faculty positions in academia to research and development in industry, in the U.S. and overseas.

For more information, visit the Chemical and Biological Engineering Department web page.

Chemical Engineering

Requirements for Admission
Students should fulfill Drexel University's general requirements for admission to graduate studies. The subjects normally included in an undergraduate program in chemical engineering provide a satisfactory background. Decisions regarding prerequisite qualifications for students who may be deficient in some areas are made after consultation with the departmental graduate advisor.

The core courses are designed for students with undergraduate training in chemical engineering. However, students with a background in biological sciences and engineering can also enroll in the core courses after completing the necessary basic engineering courses. Programs for such students are determined on an individual basis after consultation with the departmental graduate advisor.

Graduate study in chemical engineering is offered on a regular full-time basis and on a part-time basis. Details not covered in the following information may be obtained by contacting the departmental graduate advisor. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

Financial Assistance
Financial aid in the form of teaching assistantships, research assistantships, and fellowship grants is available to qualified full-time students. Awards are made annually on a competitive basis.

Master of Science Program in Chemical Engineering

In general, each program leading to the Master of Science in Chemical Engineering must meet the following requirements: core chemical engineering, 15 credits; area of concentration, 15 credits; electives, 6 credits; research, 9 credits.

The 15 credits of core courses in chemical engineering are listed below. The 9 credits of research can either be 9 credits of thesis research (CHE 898) or up to 9 credits of independent study (CHE 799), with the remaining credits taken in the area of concentration.

The thesis may be based on either a theoretical or an experimental investigation, or both, of limited scope but involving a significant degree of originality. The nature of the research may involve multidisciplinary areas such as environmental engineering, biomedical engineering, ceramic processing, molten metals processing, and other topics. The scope and content of the thesis is guided by the thesis advisor.

Courses in an area of concentration enable students to develop expertise in a technology area closely related to chemical engineering, such as environmental engineering, biochemical engineering, and materials engineering. Those contemplating a career in management of technology may consider the area of concentration in engineering management. Concentration in computer science is suggested for students interested in computer applications in chemical engineering. The courses listed under each area of concentration are recommended for students who have no prior exposure to that field. Students who have prior experience in a field should select courses in consultation with the graduate advisor.

Electives may be chosen from course offerings in chemical engineering, mathematics, science, and other engineering disciplines, subject to approval.

Full-time students usually take the core courses in the first year. Other courses may be substituted for the core courses, if equivalent courses are available and if the substitution is approved by the graduate advisor.

Seminars, attended by all full-time students and faculty, provide a forum for the discussion of original research problems and other topics of interest to chemical engineers.

Full-time students normally require a minimum of one calendar year to complete their study and research.

Some courses are offered in the late afternoon or evening for the convenience of part-time students.

Non-chemical engineering electives, other than those listed above, require prior approval by the graduate advisor. The current schedule of evening courses for part-time students are available upon request.

Curriculum

		15.0 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
	Area of concentration	15.0
	Thesis/Research	9.0
	Electives	6.0

Sample areas of Concentration:

Biochemical Engineering

Courses		Credits
BIO 500	**Biochemistry**	3.0
BIO 610	**Biochemistry of Metabolism**	3.0
BMES 501	**Medical Sciences I: Cellular and Tissue Biology**	3.0
CHE 562	**Bioreactor Engineering**	3.0
CHE 564	**Unit Operations in Bioprocess Systems**	3.0

Computer Science

Courses		Credits
CS 557	**Data Structures**	3.0
CS 558	**Analysis of Algorithms**	3.0
CS 559	**Formal Language Theory**	3.0
CS 720	**Operating Systems I**	3.0
CS 761	**Compiler Construction I**	3.0

Engineering Management

Courses		Credits
EGMT 501	**Engineering Management I**	3.0
EGMT 502	**Engineering Management II**	3.0
EGMT 504	**Communications**	3.0
EGMT 531	**Economics for Engineering Management**	3.0
EGMT 581	**Problems in Human Relations**	3.0

Environmental Engineering

Courses		Credits
ENVS 501	**Chemistry of the Environment**	3.0
ENVS 608	**Fate of Pollutants in Air and Water**	3.0
ENVE 661	**Environmental Engineering Unit Operations — Chemical and Physical**	3.0
ENVE 662	**Environmental Engineering Unit Operations — Biological**	3.0
ENVE 865	**Special Topics: Environmental Engineering**	3.0

Materials Engineering

Courses		Credits
MATE 500	**Structure and Properties of Metals**	3.0
MATE 501	**Structure and Properties of Polymers**	3.0
MATE 502	**Structure and Properties of Ceramic and Electronic Materials**	3.0
MATE 505	**Phase Equilibria**	3.0
MATE 506	**Diffusion**	3.0

PhD in Chemical Engineering

Superior students with MS or BS degrees will be considered for the doctoral program in chemical engineering. Students joining with a Master's degree may satisfy up to 45 credit hours of the PhD course/research credit requirements depending on the courses taken and/or research carried out in their Master's programs, subject to approval by graduate program advisor.

Requirements
The following general requirements must be satisfied in order to complete the PhD in chemical engineering:

- 90 credit hours total
- Qualifying exam (first year)
- Establishing a plan of study (first term)
- 15 core credits
- 15 credit hours of specialized plan of study
- 60 credit hours of research
- Candidacy exam (5th term)
- Dissertation/Thesis
- Defense of Dissertation/Thesis
- GPA requirements: 3.0 overall; 3.0 in graduate Chemical Engineering (CHE) courses; 3.0 core graduate courses

Qualifying Exam
The qualifying exam takes place in the first year. The department administers the exam twice a year – in January and June. The objective of the exam is to evaluate proficiency in core undergraduate chemical engineering material. The format is mae up of seven problems, each covering a separate core topic from the undergraduate curriculum, including thermodynamics, heat transfer, mass transfer, fluid mechanics, kinetics, control, and separations. Students must display mastery of five out of the seven topics to pass the qualifying exam. Each student will be given two opportunities to pass the qualifying exam.

Thesis Advisor/Plan of Study
All students must meet with their advisor in their first term to work out a plan of study.

Core Requirements		**15.0 Credits**
CHE 502	**Mathematical Methods**	3.0
CHE 513	**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

Specialized Plan of Study Courses	**15.0 Credits**
15.0 credit hours of courses approved by research advisor. All students are expected to develop competence in their area(s) of specialization.	

Research	**60.0 Credits**

60.0 credit hours of research (CHE 998), which may include up to 6.0 credit hours of electives.

Candidacy Exam
The objective of the candidacy exam is to determine whether the student has the potential to carry out a successful PhD project.

The components of the candidacy exam are as follows::

- Proposal Document (Written): The student is required to write a research proposal of about 15 pages, including background, preliminary results, and a research plan (with his/her advisor's input). The proposal must be submitted to each member of the student's thesis committee and to the Graduate Program Advisor **before 5:00 pm on the first day of the student's 5th term**.
- Proposal Defense (Oral): The student provides a formal defense of his/her proposal to his/her thesis committee **before the end of the student's 5th term**.

Thesis /Dissertation and Defense
As the culmination of intensive study and independent research, the doctoral dissertation represents a major scholarly endeavor; accordingly, it is recognized as the most important requirement of the degree. All doctoral candidates must present an acceptable dissertation based on significant work. The dissertation must represent a unique contribution to chemical engineering or biochemical engineering knowledge. A final oral examination is conducted, in part, as a defense of the dissertation.

A preliminary exam is targeted for the student's 12th term, with this scheduling subject to the research advisor's discretion. This preliminary exam is to ensure that the student has made adequate progress in his/her project and that s/he has gained skills to write an independent research proposal.

The requirements of the thesis/dissertation and defense include:

- Proposal Document, a.k.a. "Second Proposal": The student is required to write a research proposal of about 15 pages, including background, summary of results to date, and a plan for completion of the thesis work (with minimal advisor input). The proposal must be submitted to each member of the student's thesis committee well in advance of the oral exam date.
- Preliminary Defense (Oral Examination): The student must defend the second proposal and the thesis work to-date in an oral examination by his/her thesis committee.
- Manuscript Submission: Before taking the preliminary exam, the student is required to submit at least one paper based on his/her PhD research to a refereed journal. This must be an original article, not a review.
- A copy of the written proposal, together with a copy of the submitted paper with acknowledgment of submission from the journal editor, must be submitted to the Graduate Program Advisor before the Preliminary Defense and at least 6 months before the Thesis Defense.
- The student is responsible for scheduling the Preliminary Defense
- Students should submit a copy of the Preliminary Exam Reporting Form no later than three days after the exam.

For more information, visit the Chemical and Biological Engineering Department web page.

Civil Engineering

Program Objectives
The graduate program in civil engineering offers students the opportunity to develop a more fundamental and complete understanding of the principles that govern their field as well as current design methodology. Students are encouraged to be innovative and imaginative in their quest for recognizing, stating, analyzing, and solving engineering problems.

The goal of the master's program is to develop technical depth of expertise for a professional career in the planning, design, construction, and operation of large-scale infrastructure systems, built facilities, and water resources management. The goal of the PhD program is to develop the abilities to discover, pursue, and apply basic knowledge. PhD recipients are prepared to engage in teaching and research or in an industrial career in the development of new concepts and innovative systems.

General Information
The civil engineering programs comprise the following areas of specialization: building systems, geotechnical engineering, hydraulic and coastal engineering, structural engineering, and water resources.

For more information, visit the Department of Civil, Architectural and Environmental Engineering web page.

Civil Engineering

Requirements for Admission

MS admission is based on an academic record demonstrating adequate preparation and potential for successful graduate study. This typically includes a BS from an engineering curriculum accredited by the Accrediting Board for Engineering and Technology (ABET) or the equivalent from a non-U.S. institution. Submission of results from the Graduate Record Exam (GRE) is required. A grade point average (GPA) of 3.0 is usually required. Graduates who do not have a bachelor's degree in either Civil, Architectural or Environmental Engineering may be required to take preparatory undergraduate courses.

Master of Science Program in Civil Engineering

The programs of study at the master's level continue the specialization developed at the senior level of the undergraduate program or newly developed interests. The Master of Science in Civil Engineering degree may be elected by graduates of ABET-accredited undergraduate programs in civil engineering and related fields. Admission and prerequisites are determined on the basis of a student's undergraduate transcript.

Most MSCE graduates work as professional engineers in consulting firms, industry, or governmental agencies. A number of our graduates have started consulting and construction firms in the Philadelphia area and have been very successful. Other former students hold prominent positions in public utilities, local government agencies, and industry.

The full-time graduate academic program is closely associated with the research efforts of the faculty. Full-time master's degree candidates are encouraged to base their master's thesis on some aspect of faculty research. The one-to-one relationship between student and faculty member provides an invaluable learning experience. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

The master's degree requires a total of 45 credits, of which 24 credits must be in the major field of interest and 6 credits are to fulfill math requirements. The remaining credits are taken as electives in related areas. The choice of core and elective courses is made in consultation with the student's graduate advisor.

Areas of concentration include:

- Structural
- Geotechnical/geoenviornmental/geosynthetics
- Water resources
- Sustainable engineering
- Building systems/energy

Dual graduate degrees are possible. Among the more popular programs are combining the MS in Civil Engineering with an MS in Environmental Engineering, or Engineering Management. The required credits must meet all civil engineering program requirements and will be determined on the basis of the student's proposed program of study.

Doctoral Program in Civil Engineering

Doctoral Program
The PhD degree is awarded for original research on a significant civil engineering problem. Graduate students who have completed their MS degrees work closely with individual faculty members (see Faculty Research Interests below). PhD dissertation research is usually supported by a research grant from a government agency or an industrial contract.

The full-time graduate academic program is closely associated with the research efforts of the faculty. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursing full-time study.

Doctoral students normally take at least 45.0 credits, including research credits, beyond the master's degree requirements. Full-time residency for one continuous academic year is required for the PhD degree to ensure students the opportunity for intellectual association with other scholars. Many doctoral students take two, three, or four years of full-time graduate study to complete their degrees. Involvement in the teaching activity of the Civil, Architectural and Environmental Engineering Department is required of all PhD applicants.

After approximately one year of study beyond the master's degree, doctoral students take a candidacy examination, consisting of written and oral parts. Each PhD candidate is supervised by a major professor and a doctoral committee chaired by the major professor.

PhD candidates submit a detailed proposal for dissertation research to the doctoral committee. The students then take a proposal examination; successful completion of this examination is required to become a PhD candidate. After approval of the proposal, the committee meets from time to time to review the progress of the research. The dissertation must be submitted to the doctoral committee at least 90 days before the graduation date. The committee schedules and conducts a final oral examination before approval of the dissertation.

Areas of research include:

- Structural
- Geotechnical/geoenviornmental/geosynthetics
- Water resources
- Sustainable engineering
- Building systems/energy

Computer Science

The Master of Science in Computer Science
The Master of Science in Computer Science is designed to provide breadth of understanding in the core topics of computer science, in-depth advanced material, and a range of topics courses in the research areas of the faculty. A balance of theory and practice is presented preparing students to perform cutting edge research as well as training students to become practicing computational scientists, computer specialists or software engineers in business, industry or government. A thesis option is available to prepare students for doctoral studies or other research-oriented career paths.

The Doctorate in Computer Science
Students enrolled in the PhD program are expected to acquire broad knowledge in all areas of computer science and an overall perspective of the field, its structure, and its problems. They are expected to study at least one subfield in considerable depth, and to make substantial contributions to that subfield through creative research and serious scholarship. The program is designed for students to advance their basic understanding of information processes and to contribute to the creation and consolidation of knowledge in computer science. In addition, they should be able to see and understand new problems between different areas within computer science, as well as between computer science and other fields, and to find and implement imaginative solutions.

The Doctorate in Computer Science is structured to serve both full and part-time students.

For more information, visit the Department of Computer Science web site.

Computer Science Graduate Programs

Requirements for Admission
Applicants should hold a BS degree in computer science or some related technical area and meet the graduate admission standards for Drexel University. Students without a bachelor's degree in computer science may be admitted to the computer science program only after completing a set of prerequisite courses.

All applicants must take the Graduate Record Exam (GRE).All international students must have an acceptable score on the Test of English as a Foreign Language (TOEFL) exam.

Applicants for post-master's status must show potential for further study by having maintained at least a 3.0 average in their master's level studies.

Applications are evaluated by the department Admissions Committee and admission is determined by the department's Graduate Advisor. The Admissions Committee evaluates all credentials submitted by applicants to determine a student's ability and potential to succeed in graduate study. In addition, the committee is interested in the applicant's potential to contribute to his/her program of study and to the University community as a whole.

Application forms may be obtained from the Drexel Admissions web site.

MS in Computer Science

45.0 Credits

General Requirements

Students must complete a minimum of 45 graduate credits for the MS degree. All students are required to submit a plan of study form with the Graduate Advisor at the beginning of their studies. Significant changes to the plan of study should be discussed with the Graduate Advisor.

Precore Classes

Precore classes are graduate level courses, but are not considered graduate level CS courses. These courses only count towards the degree requirement listed below for "three additional graduate level courses." Precore courses are intended for students without adequate CS background. The material in these courses is considered prerequisite knowledge for all other graduate CS courses.

- CS 520 Foundations of Computer Science
- CS 570 Programming Tools and Environments

Degree Requirements

Core Courses		Credits
CS 521	**Data Structures and Algorithms I**	3.0
CS 522	**Data Structures and Algorithms II**	3.0
CS 525	**Theory of Computation**	3.0
CS 550	**Programming Languages**	3.0
CS 543	**Operating Systems**	3.0
CS 544	**Computer Networks**	3.0

Computer Science Breadth Requirement

Students select three intermediate courses, from at least two areas, from the following list:

Note: Some special topics courses (CS 680) may also count towards the breadth requirement. Contact the Graduate Advisor for more information.

Algorithms and Theory		
CS 621	**Approximation Algorithms**	3.0
CS 623	**Computational Geometry**	3.0

Artificial Intelligence and Robotics		
CS 510	**Artificial Intelligence**	3.0
CS 511	**Robot Building Lab**	3.0
CS 610	**Advanced Artificial Intelligence**	3.0
CS 612	**Knowledge Based Agents**	3.0
CS 613	**Machine Learning**	3.0
CS 615	**Intelligent Time-Critical Systems**	3.0

Computer Architecture

ECEC 621	**Applied Computer Architecture I (High-performance Computer Architecture)**	3.0
ECEC 622	**Applied Computer Architecture II (Parallel Computer Architecture)**	3.0

Computer Vision

CS 580	**Introduction to Computer Vision**	3.0
CS 584	**Advanced Computer Vision**	3.0

Human Computer Interaction and Computer Graphics

CS 536	**Computer Graphics**	3.0
CS 530	**Developing User Interfaces**	3.0
CS 637	**Interactive Computer Graphics**	3.0

Numeric and Symbolic Computation

CS 567	**Applied Symbolic Computation**	3.0
CS 668	**Computer Algebra I**	3.0

Programming Languages and Compilers

CS 551	**Compiler Construction I**	3.0
CS 552	**Compiler Construction II**	3.0

Software Engineering

CS 575	**Software Design**	3.0
CS 576	**Dependable Software Systems**	3.0

Systems

CS 643	**Advanced Operating Systems**	3.0
ECEC 632	**Computer Network Design II**	3.0
CS 500	**Database Theory**	3.0

Computer Science Depth Requirement

Depth requirement courses should build on basic material obtained from the breadth requirement courses, from the research articles, and include a research project. Some special topics courses (CS680) or advanced seminars (e.g. CS 729) may also count towards the depth requirement. Contact the Graduate Advisor for further information about particular courses.

Students select one advanced course from the following:

CS 630	**Cognitive Systems**	3.0
CS 636	**Advanced Computer Graphics**	3.0
CS 645	**Cryptography and Network Security**	3.0
CS 662	**Numerical Analysis II**	3.0
CS 675	**Reverse Software Engineering**	3.0
CS 676	**Parallel Processing**	3.0
CS 669	**Computer Algebra II**	3.0
ECEC 623	**Applied Computer Architecture III (Advanced Parallel Computer Architecture)**	3.0
ECEC 633	**Computer Network Design III (Advanced Topics in Computer Networks)**	3.0

Thesis Option
Usually students pursuing a Master's Thesis will first do 3 research credits (CS 897 or CS 997) to obtain background knowledge required by the thesis topic. It is the responsibility of the student to find a thesis supervisor.

CS 898	**Master's Thesis**	6.0

Non-thesis Option
The non-thesis option requires two additional courses from either intermediate level or advanced level courses listed above.

Three additional graduate level courses are required:

These courses may come from either intermediate or advanced courses. In addition, courses may be taken outside the department, may include CS 897 (Independent Study), CS 997 (Research in Computer Science), and precore Computer Science courses listed in requirement (0). Any course not explicitly listed above, including independent study and research courses, must be approved by the Graduate Advisor.

Other courses, such as special topics, the department offers may qualify for meeting intermediate or advanced requirements. Students must check with the department to see if this is the case. Any course offered by other departments not listed here must be approved by the Graduate Advisor, or they will not count towards the degree.

PhD in Computer Science

90.0 credits

General Requirements

The following general requirements must be satisfied in order to complete the PhD in Computer Science:

- 90.0 credit hours total
- Establishing a plan of study with your Advisor
- 10 breadth requirement courses
- 3 advanced courses, plus 3 additional independent study courses (approved by student's advisor) toward the depth requirement
- Qualifying exam
- Candidacy exam
- Approval of dissertation proposal
- Defense of dissertation

Full Requirements

Students entering with a master's degree may be exempted from some or all of the courses in the breadth requirement; however, they are still required to take and pass the qualifying exam. In addition students may receive up to 45.0 transfer credits for an existing MS degree in Computer Science or related field. Individual courses may also be transferred with approval of the Graduate Advisor. The total credit amount, candidacy exam, and dissertation are University Requirements. Additional requirements are determined by the department offering the degree.

Students take the following three (3) core requirement courses:		**9.0 Credits**
CS 521	**Data Structures and Algorithms I**	3.0
CS 525	**Theory of Computation**	3.0
CS 550	**Programming Languages**	3.0

Students select (3) flexible core requirement courses from the following list:		**9.0 Credits**
CS 510	**Introduction to Artificial Intelligence**	3.0
CS 522	**Data Structures and Algorithms II**	3.0
CS 530	**Developing User Interfaces**	3.0
CS 536	**Computer Graphics**	3.0
CS 540	**High Performance Computing**	3.0
CS 543	**Operating Systems**	3.0
CS 544	**Computer Networks**	3.0
CS 567	**Applied Symbolic Computation**	3.0
CS 576	**Dependable Software Systems**	3.0
CS 583	**Introduction to Computer Vision**	3.0

In addition, all students are required to take an additional four (4) breadth requirement electives, developing background knowledge in an area of particular interest. These courses are organized into the following seven areas.

Students must take courses from at least two different areas:

Artificial Intelligence

CS 510	**Artificial Intelligence**	3.0
CS 511	**Robot Building Lab**	3.0
CS 610	**Advanced Artificial Intelligence**	3.0
CS 612	**Knowledge Based Agents**	3.0
CS 613	**Machine Learning**	3.0

Algorithms and Theory

CS 620	**Advanced Data Structures and Algorithms**	3.0
CS 621	**Approximation Algorithms**	3.0
CS 623	**Computational Geometry**	3.0
CS 759	**Complexity Theory**	3.0
CS 680	**Special Topics in Algorithms**	3.0

Human Computer Interaction and Computer Graphics

CS 530	**Developing User Interfaces**	3.0
CS 536	**Computer Graphics**	3.0
CS 583	**Introduction to Computer Vision**	3.0
CS 584	**Advanced Computer Vision**	3.0
CS 613	**Computing Off the Desktop**	3.0
CS 630	**\Cognitive Modeling**	3.0
CS 636	**Advanced Computer Graphics**	3.0
CS 637	**Interactive Graphics**	3.0
PSY 612	**Psychology of Human-Computer Interaction**	3.0

Numeric and Symbolic Computation

CS 680 / MATH 540	**Numeric Computing**	3.0
CS 680 / MATH 521	**Numerical Analysis II**	3.0
CS 680 / MATH 522	**Numerical Analysis III**	3.0
CS 567	**Applied Symbolic Computation**	3.0
CS 668	**Computer Algebra I**	3.0
CS 669	**Computer Algebra II**	3.0

Programming Languages and Compilers

CS 551	**Compiler Construction I**	3.0
CS 552	**Compiler Construction II**	3.0
CS 650	**Programming Generalization and Optimization**	3.0

Software Engineering

CS 575	**Software Design**	3.0
CS 576	**Dependable Software Systems**	3.0
CS 675	**Reverse Engineering**	3.0
CS 680	**Special Topics in Software Engineering**	3.0

Networks and Operating Systems

CS 643	**Advanced Operating Systems**	3.0
CS 645	**Network Security**	3.0
CS 647	**Distributed Systems Software**	3.0
CS 676	**Parallel Processing**	3.0
CS 741	**Computer Networks II**	3.0

Miscellaneous

CS 500	**Database Theory**	3.0

CS 540	**High Performance Computing**	3.0
CS 751	**Database II**	3.0

Depth Requirement Courses
Doctoral Students are required to complete at least three (3) CS courses beyond the breadth requirement. These courses should be advanced courses listed in the areas under the breadth requirement, appropriate special topics courses, or advanced topics courses covering current research in selected areas. All course selection must be made with the student's advisor.

Independent Study
Students are required to take 9.0 additional credits of independent study work. Selection of independent studies should be made in consultation with the student's advisor. This work is intended to prepare the student for later research.

Plan of Study
Upon entering the PhD program, each student will be assigned an academic advisor, and with the help of the advisor will develop and file a plan of study (which can be brought up to date when necessary). There is considerable flexibility in the choice of study plan; however, all PhD students are required to satisfy a breadth requirement of 10 courses (30.0 credits) and a depth requirement of 3 advanced courses (9.0 credits) and 9.0 credits of Independent Study. The plan of study should be filed with the Graduate Coordinator no later than the end of the first term.

Qualifying Exam
The goal of this examination is to review and appraise a student's standing in the program, to test how well (s)he is prepared for research, and to discover whether or not the student understands the subject matter sufficiently well to carry out good research. The Qualifying Exam is a written exam and is based on material covered in the six core courses from the breadth requirement. Students beginning their graduate education in the program must take the Qualifying Exam by the end of their second year. Students beginning the CS Ph.D. program post-master's must take the Qualifying Exam by the end of their first year.

Candidacy Exam
The Computer Science candidacy examination serves to define the student's research domain and to evaluate the student's knowledge and understanding of various fundamental and seminal results in that domain. At this point the student is expected to be able to read, understand, analyze, and explain advanced technical results in a specialized area of computer science at an adequate level of detail. The candidacy examination will evaluate those abilities using a defined set of published manuscripts. The student will prepare a written summary of the contents of the material, present the summary orally, and answer questions about the material. The examination committee will evaluate the written summary, the oral presentation, and the student's answers. They must advance to candidacy by taking both Written and Oral Examinations no later than one year after passing the Qualifying Exam and passing it no later than one and a half years after passing the Qualifying Exam.

Thesis Proposal
After completing the candidacy examination successfully, the PhD candidate must prepare a thesis proposal that outlines, in detail, the specific problems that will be solved in the PhD dissertation. The quality of the research proposal should be at the level of, for example, a peer-reviewed proposal to a federal funding agency, or a publishable scientific paper. The candidate is responsible for sending the research proposal to the PhD committee two weeks before the oral presentation. The PhD committee need not be the same as the candidacy exam committee, but it follows the same requirements and must be approved by the Office of Graduate Studies. The oral presentation involves a 30-minute presentation by the candidate followed by an unspecified period during which the committee will ask questions.

After the question and answer period, the candidate will be asked to leave the room and the committee will determine if the research proposal has been accepted. The research proposal can be repeated at most once. A thesis proposal must be approved within two years of becoming a PhD candidate.

Thesis Defense

After completing the research proposal successfully, the PhD candidate must conduct the necessary research and publish the results in a PhD dissertation. The dissertation must be submitted to the PhD committee two weeks prior to the oral defense. The oral presentation involves a 45-minute presentation by the candidate, open to the public, followed by an unspecified period during which the committee will ask questions. The question-and-answer period is not open to the public. After the question and answer period, the candidate will be asked to leave the room and the committee will determine if the candidate has passed or failed the examination. The candidate will be granted one more chance to pass the final defense if (s)he fails it the first time. Paperwork selecting the thesis committee and indicating the results of the thesis defense must be filed with the Department of Computer Science and the Office of Graduate Studies.

Dual MS Degree in Mathematics and Computer Science

Students with interest and strong backgrounds in both mathematics and computer science are encouraged to pursue a dual degree in mathematics and computer science, or to combine their studies with a field outside the department. Some popular combinations include mathematics/physics, computer science/computer engineering, computer science/biomedical engineering, and computer science/software engineering.

Typically, this requires an additional half-year of study beyond that required for an MS in either field. Both degrees are awarded simultaneously upon completion of this program. The MS is awarded after satisfactory completion of a minimum of 45 credit hours, including 27 hours of core courses in an area of specialization. The specializations are applied mathematics, statistics and operations research, scientific computation, and computer science. Students specializing in scientific computation may earn the MS in either mathematics or computer science.

Computer Engineering

General Information

The Master of Science in Computer Engineering degree requires a minimum of 45 approved credits chosen in accordance with a plan of study arranged in consultation with the student's advisor and the departmental graduate advisor. Up to but not exceeding 9 research/thesis credits may be taken by students who choose to write a Master's thesis. Students who elect a non-thesis option are also encouraged to engage in research, by registering for supervised research credits (not to exceed 9 credits).

For more information, visit the Department of Electrical and Computer Engineering web site.

Computer Engineering

Requirements for Admission

Applicants should preferably have an undergraduate degree equivalent to a U.S. bachelor's degree in computer engineering, computer science, or electrical engineering. Students holding degrees in other engineering and science disciplines with appropriate coursework or training will also be considered.

Appropriate coursework includes experience with all of the following: Software (advanced programming and operating systems); Computer Architecture (digital systems design, computer organization and architecture); Algorithms and Data Structures; Computer Networks. Students must have a minimum 3.0 GPA (on a 4.0 scale) for the last two years of undergraduate studies, as well as for any subsequent graduate-level work.

The GRE General Test is required of applicants to full-time MS and PhD programs. Students whose native language is not English and who do not hold a degree from a U.S. institution must take the Test of English as a Foreign Language (TOEFL).

Master of Science in Computer Engineering

The Master of Science in Computer Engineering curriculum encompasses 45.0 or 48.0 (with the Graduate Co-op option) approved credit hours, chosen in accordance with the following requirements and a plan of study arranged with the departmental graduate advisor in consultation with the student's research advisor, if applicable. Before the end of the first quarter in the Department of Electrical and Computer Engineering, for a full-time student, or by the end of the first year for a part-time student, said plan of study must be filed and approved for a plan of study with the departmental graduate advisor.

A total of at least 30.0 credit hours must be taken from among the graduate course offerings of the Department of Electrical and Computer Engineering. These credits must be taken at Drexel University. No transfer credit may be used to fulfill these requirements, regardless of content equivalency.

These departmental credit hours are as follows:

- 18.0 credits of Computer Engineering Courses (ECEC)
- 6.0 credits if Electrical Engineering Courses (ECEE, ECEP, ECES, ECET)
- 6.0 credits of General Electrical and Computer Engineering Courses (ECEC, ECEE, ECEP, ECES, ECET)

The required 18 credits of coursework in Computer Engineering must also meet the following criteria:

Core Courses
The Computer Engineering core courses consist of two courses:

- ECEC 621: High-Performance Computer Architecture
- ECEC 631: Principles of Computer Networking

Sequence Courses
Besides the two core courses, students must also complete a three course Computer Engineering (ECEC) sequence. This requirement may be fulfilled by taking the remaining two courses of one of the two sequences started as part of the core course requirement or by completing an entirely separate three course sequence in Computer Engineering.

With the remaining required 15 credit hours, students may take graduate coursework, subject to the approval of the departmental graduate advisor, in electrical and computer engineering, mathematics, physics or other engineering disciplines.

Although not required, students are encouraged to complete a Master's Thesis as part of the MS studies. Those students who choose the thesis option may count up to 9 research/thesis credits as part of their required credit hour requirements.

Graduate Co-Op Program
Students may choose to participate in the Graduate Co-op (Grad Co-op) Program, where they earn 6 academic credits for working in industry on computer engineering related projects. Three of these credits may be used to satisfy either the "approved free-elective" credits for the non-thesis option, or toward satisfying the 12 required credits of Engineering and/or Mathematics and Computer Science courses for the

thesis option. The students choosing the Grad Co-op option will need a total of 48 credits for graduation.

For more information on curricular requirements, visit the Department of Electrical and Computer Engineering's web site.

Non-thesis option

	Computer engineering courses	18.0
	Electrical engineering courses	6.0
	Engineering and/or math/computer science courses	12.0
	Electrical engineering or computer engineering electives	6.0
	Approved free elective	3.0

Thesis option

	Computer engineering courses	18.0
	Electrical engineering courses	6.0
	Engineering and/or math/computer science courses	12.0
	MS thesis	9.0

Computer Engineering Courses

Courses		**Credits**
ECEC 501	**Principles of Representation and Reasoning**	3.0
ECEC 502	**Principles of Data Analysis and Regularity Recognition**	3.0
ECEC 503	**Principles of Decision Making, Planning, and Control**	3.0
ECEC 511	**Issues in Combinational Circuit Design**	3.0
ECEC 512	**Issues in Sequential Circuit Design**	3.0
ECEC 513	**Design for Testability**	3.0
ECEC 621	**High-performance Computer Architecture**	3.0
ECEC 622	**Parallel Computer Architectures**	3.0
ECEC 623	**Advanced Parallel Computer Architectures**	3.0
ECEC 631	**Principles of Computer Networking**	3.0
ECEC 632	**Performance Analysis of Computer Networks**	3.0
ECEC 633	**Advanced Topics in Computer Networks**	3.0
ECEC 661	**VLSI Design**	3.0
ECEC 662	**VLSI Array Processors I**	3.0
ECEC 663	**VLSI Array Processors II**	3.0

Please note that ECEC 500 (Fundamentals of Computer Hardware) and ECEC 600 (Fundamentals of Computer Networks) do not count towards the credit requirements needed to complete the M.S. in Computer Engineering degree program..

PhD in Electrical Engineering

90.0 credits

General Requirements

The following general requirements must be satisfied in order to complete the PhD in Electrical Engineering:

- 90.0 credit hours total
- candidacy examination
- research proposal
- dissertation defense

Students entering with a master's degree in electrical or computer engineering or a related field will be considered a post-masters PhD student and will only be required to complete a total of 45.0 credit hours, in accordance with University policy.

Curriculum

Appropriate coursework is chosen in consultation with the student's research advisor. A plan of study must be developed by the student to encompass the total number of required credit hours. Both the departmental graduate advisor and the student's research advisor must approve this plan.

Candidacy Examination

The candidacy examination explores the depth of understanding of the student in his/her specialty area. The student is expected to be familiar with, and be able to use, the contemporary tools and techniques of the field and to demonstrate familiarity with the principle results and key findings.

The student, in consultation with his/her research advisor, will declare a principal technical area for the examination. The examination includes the following three parts:

- A self-study of three papers from the archival literature in the student's stated technical area, chosen by the committee in consultation with the student.
- A written report (15 pages or less) on the papers, describing their objectives, key questions and hypotheses, methodology, main results and conclusions. Moreover, the student must show in an appendix independent work he/she has done on at least one of the papers – such as providing a full derivation of a result or showing meaningful examples, simulations or applications.
- An oral examination which takes the following format:
    - A short description of the student's principal area of interest (5 minutes, by student).
    - A review of the self-study papers and report appendix (25-30 minutes, by students).
    - Questions and answers on the report, the appendix and directly related background (40-100 minutes, student and committee).

In most cases, the work produced during the candidacy examination will be a principal reference for the student's PhD dissertation; however, this is not a requirement.

Research Proposal

Each student, after having attained the status of PhD Candidate, must present a research proposal to a committee of faculty and industry members, chosen with his/her research advisor, who are knowledgeable in the specific area of research. This proposal should outline the specific intended subject of study, i.e., it should present a problem statement, pertinent background, methods of study to be employed, expected difficulties and uncertainties and the anticipated form, substance and significance of the results.

The purpose of this presentation is to verify suitability of the dissertation topic and the candidate's approach, and to obtain the advice and guidance of oversight of mature, experienced investigators. It is not to be construed as an examination, though approval by the committee is required before extensive work is undertaken. The thesis proposal presentation must be open to all; announcements regarding the proposal presentation must be made in advance.

The thesis advisory committee will have the sole responsibility of making any recommendations regarding the research proposal. It is strongly recommended that the proposal presentation be given as soon as possible after the successful completion of the candidacy examination. The student must be a PhD candidate for at least one year before he/she can defend his/her doctoral thesis.

Dissertation Defense
Dissertation Defense procedures are described in the Office of Graduate Studies policies regarding Doctor of Philosophy Program Requirements. The student must be a PhD candidate for at least one year before he/she can defend his/her doctoral thesis.

Electrical Engineering

General Information

The Master of Science in Electrical Engineering degree requires a minimum of 45 approved credits chosen in accordance with a plan of study arranged with the permission of a student’s advisor and the departmental graduate advisor. Students who complete a six-month period of internship through Drexel’s Graduate Co-op Program (GCP) must complete 48 credits including 6 GCP credits.

The plan must contain a selection of core courses from the department's offerings and may include appropriate graduate courses from other engineering departments or from physics or mathematics. Further information can be obtained from the department office or from the graduate advisor.

All students also are encouraged to engage in thesis research. The combined thesis and research cannot exceed 9 credits.The program is organized so that a student may complete the degree requirements in two years of full-time study or three years of part-time study.

For more information about the programs, including information about teaching and research assistantships, visit the Department's Electrical Engineering web site.

Electrical Engineering

Requirements for Admission

Applicants must satisfy general requirements for graduate admission, including a minimum 3.0 GPA (on a 4.0 scale) for the last two years of undergraduate studies, as well as for any subsequent graduate work, and hold a bachelor's degree or the equivalent in electrical engineering, computer engineering, or the equivalent from an accredited college or university. A degree in science (physics, mathematics, computer science, etc.) is also acceptable. Applicants with degrees in sciences may be required to take a number of undergraduate engineering courses. An undergraduate degree earned abroad must be deemed equivalent to a U.S. bachelor's.

Applicants for full-time MS and PhD programs must take the GRE general test. Students whose native language is not English and who do not hold a degree from a U.S.institution must take the TOEFL within two years before application. TOEFL scores must be a minimum of 600 (paper based), 250 (CBT) and 100 (IBT).

Master of Science in Electrical Engineering

The Master of Science in Electrical Engineering curriculum encompasses 45.0 or 48.0 (with the Graduate Co-op option) approved credit hours, chosen in accordance with the following requirements and a plan of study arranged with the departmental graduate advisor in consultation with the student's research advisor, if applicable. Before the end of the first quarter in the Department of Electrical and Computer Engineering, for a full-time student, or by the end of the first year for a part-time student, said plan of study must be filed and approved for a plan of study with the departmental graduate advisor.

A total of at least 30.0 credit hours must be taken from among the graduate course offerings of the Department of Electrical and Computer Engineering. These credits must be taken at Drexel University. No transfer credit may be used to fulfill these requirements, regardless of content equivalency.

Students completing an MS in Electrical Engineering must choose to complete the requirements for one of the five concentrations offered by the Department of Electrical and Computer Engineering. The required departmental credit hours must be broken down into the following manner based on the chosen concentration.

(*Scroll down to below the concentration courses for an explanation of the options for fulfilling the additional 15.0 credit hours).

Electrophysics Concentration

Required courses:

ECEE	**Electrophysics courses (ECEE courses)**	18.0
	General Electrical and Computer Engineering courses (ECEC, ECEE, ECEP, ECES, ECET) courses	12.0

Controls, Robotics, Intelligent Systems Concentration

Required courses:

ECES 511	**Fundamentals in Systems I**	3.0
ECES 512	**Fundamentals in Systems II**	3.0
ECES 521	**Probability and Random Variables**	3.0
ECES 522	**Random Process and Spectral Analysis**	3.0
	General Electrical and Computer Engineering courses (ECEC, ECEE, ECEP, ECES, ECET) courses	

To meet the requirements of this concentration, students select three (3) of the following courses:

ECES 604	**Optimal Estimation and Stochastic Control**	3.0
ECES 642	**Optimal Control**	3.0
ECES 644	**Computer Control Systems**	3.0
ECES 651	**Intelligent Control**	3.0
ECES 817	**Non-Linear Control Systems**	3.0
ECES 818	**Machine Learning/Adaptive Control**	3.0

Power Engineering

Required courses:

ECEP 501	**Power System Analysis**	3.0
ECEP 502	**Computer Analysis Power Systems**	3.0
ECEP 503	**Synchronous Machine Modeling**	3.0
	General Electrical and Computer Engineering courses (ECEC, ECEE, ECEP, ECES, ECET) courses	15.0

To meet the requirements of this concentration, students select one of the following two sequences:

ECES 511	**Fundamentals in Systems I**	3.0
ECES 512	**Fundamentals in Systems II**	3.0
or		
ECES 521	**Probability and Random Variables**	3.0
ECES 522	**Random Process and Spectral Analysis**	3.0

Signal/Image Processing

Required courses:

ECES 521	**Probability and Random Variables**	3.0
ECES 522	**Random Process and Spectral Analysis**	3.0
ECES 523	**Detection and Estimation Theory**	3.0
ECES 631	**Fundamentals of Deterministic Digital Signal Processing**	3.0
ECES 682	**Fundamentals of Image Processing**	3.0
	General Electrical and Computer Engineering courses (ECEC, ECEE, ECEP, ECES, ECET) courses	15.0

Non-designated Specialization

Required courses:

	Three 3-course departmental sequences**	27.0
	General Electrical and Computer Engineering courses (ECEC, ECEE, ECEP, ECES, ECET) courses	15.0

**Students should check with the departmental graduate advisor for more information about these sequences.

***Additional Requirements/Options** **15.0**

With the remaining required 15.0 credit hours, students may take graduate coursework, subject to the approval of the departmental graduate advisor, in electrical and computer engineering, mathematics, physics or other engineering disciplines.

Although not required, students are encouraged to complete a Master's Thesis as part of the MS studies. Those students who choose the thesis option may count up to 9 research/thesis credits as part of their required credit hour requirements.

Students may choose to participate in the Graduate Co-Op Program, where 6.0 credit hours can be earned for a six month co-operative education experience in industry, working on curriculum related projects. The total number of required credit hours is increased to 48 for those students who choose to pursue the Graduate Co-Op option. This change represents an increase in non-departmental required credit hours to a total of 18.0 credit hours, 6.0 of which are earned from the co-operative education experience. For more information on curricular requirements, visit the Department of Electrical and Computer Engineering's web site.

PhD in Electrical Engineering

90.0 credits

General Requirements

The following general requirements must be satisfied in order to complete the PhD in Electrical Engineering:

- 90.0 credit hours total
- candidacy examination
- research proposal
- dissertation defense

Students entering with a master's degree in electrical or computer engineering or a related field will be considered a post-masters PhD student and will only be required to complete a total of 45.0 credit hours, in accordance with University policy.

Curriculum

Appropriate coursework is chosen in consultation with the student's research advisor. A plan of study must be developed by the student to encompass the total number of required credit hours. Both the departmental graduate advisor and the student's research advisor must approve this plan.

Candidacy Examination

The candidacy examination explores the depth of understanding of the student in his/her specialty area. The student is expected to be familiar with, and be able to use, the contemporary tools and techniques of the field and to demonstrate familiarity with the principle results and key findings.

The student, in consultation with his/her research advisor, will declare a principal technical area for the examination. The examination includes the following three parts:

- A self-study of three papers from the archival literature in the student's stated technical area, chosen by the committee in consultation with the student.
- A written report (15 pages or less) on the papers, describing their objectives, key questions and hypotheses, methodology, main results and conclusions. Moreover, the student must show in an appendix independent work he/she has done on at least one of the papers – such as providing a full derivation of a result or showing meaningful examples, simulations or applications.
- An oral examination which takes the following format:
    - A short description of the student's principal area of interest (5 minutes, by student).
    - A review of the self-study papers and report appendix (25-30 minutes, by students).
    - Questions and answers on the report, the appendix and directly related background (40-100 minutes, student and committee).

In most cases, the work produced during the candidacy examination will be a principal reference for the student's PhD dissertation; however, this is not a requirement.

Research Proposal

Each student, after having attained the status of PhD Candidate, must present a research proposal to a committee of faculty and industry members, chosen with his/her research advisor, who are knowledgeable in the specific area of research. This proposal should outline the specific intended subject of study, i.e., it should present a problem statement, pertinent background, methods of study to be employed, expected difficulties and uncertainties and the anticipated form, substance and significance of the results.

The purpose of this presentation is to verify suitability of the dissertation topic and the candidate's approach, and to obtain the advice and guidance of oversight of mature, experienced investigators. It is not to be construed as an examination, though approval by the committee is required before extensive work is undertaken. The thesis proposal presentation must be open to all; announcements regarding the proposal presentation must be made in advance.

The thesis advisory committee will have the sole responsibility of making any recommendations regarding the research proposal. It is strongly recommended that the proposal presentation be given as soon as possible after the successful completion of the candidacy examination. The student must be a PhD candidate for at least one year before he/she can defend his/her doctoral thesis.

Dissertation Defense
Dissertation Defense procedures are described in the Office of Graduate Studies policies regarding Doctor of Philosophy Program Requirements. The student must be a PhD candidate for at least one year before he/she can defend his/her doctoral thesis.

Engineering Management

General Information
In our increasingly complex, technologically-oriented economy, demand has risen for professionals with the expertise to manage both human and technological resources — a combination of talents crucial to organizations competing in the global marketplace. Students graduating with the MS in engineering management are significantly better positioned to meet the new challenge.

Engineering Management is a multidisciplinary program offering a core curriculum and specialization in a selected area of technology or management. Study can be on a part-time or full-time basis, and all courses are offered online. Majors in engineering management must hold a bachelor's degree in engineering, basic science, or a related field. The program is open to those professionals who aspire to be engineering or technically based managers.

For more information about the program, visit the Drexel eLearning Engineering Management page.

Dual-Degree Requirements
Students may simultaneously pursue the MS in engineering management and another MS degree. Students must satisfy program requirements for each degree, with a maximum of 15 credits transferred from one program to the other. (The MS in engineering management requires 48 credits; if the other degree requires 45 credits, then 63 credits are required under the dual degree program.) Approval for the dual degree program must be obtained from the program advisor in each department.

Graduate Co-op Program (GCP)
The Graduate Co-op Program (graduate intern or co-op program) is available to master's-level engineering management students. The opportunity to spend six months in industry provides a significant opportunity for the engineer in transition to management. Through Drexel's Steinbright Career Development Center, students can explore new career directions. This program requires 6 additional credits, 3 for each term in industry.

Master of Science Program in Engineering Management

Degree Requirements
The MS degree requires 48 credits, including 33 credits in required core courses and 15 graduate elective credits, of which 6 or more credits are in a major area of interest. These electives may be taken in other colleges at Drexel consistent with the plan of study and any required prerequisites.

Students with a particular interest in technology or management who can satisfy the prerequisite and departmental requirements are free to select any 6- to 15-credit sequence with the approval of the program director. Alternatively, students may take the balance of required elective credits from any other graduate-level course(s) in engineering, business, or another college for which they have adequate preparation and can obtain approvals from the college and the Engineering Management program.

All candidates are urged to discuss their areas of interest with the program director and to develop a proposed plan of study during the early stages of their program.

Curriculum

Core courses		Credits
Engineering Management		
EGMT 501	**Engineering Management I**	3.0
EGMT 502	**Engineering Management II**	3.0
EGMT 504	**Communications**	3.0
EGMT 581	**Problems in Human Relations**	3.0
Finance & Business Policy		
EGMT 531	**Economics for Engineering Management**	3.0
EGMT 535	**Financial Management I**	3.0
EGMT 536	**Financial Management II**	3.0
EGMT 537	**Problems in Engineering Administration**	3.0
Quantitative Analysis		
EGMT 571	**Managerial Statistics I**	3.0
EGMT 572	**Managerial Statistics II***	3.0
EGMT 573	**Operations Research I**	3.0
EGMT 574	**Operations Research II**	3.0

*EGMT 572 requires as a prerequisite EGMT 571 (Managerial Statistics I) or approval from the department by completing a waiver and requesting to take and pass the STAT Placement exam in place of EGMT 571.Students may take EGMT 571, but credit for it is not applicable to the degree. EGMT 571 is offered in the summer term.

Note: Specific course requirements will be waived for students who have taken equivalent courses elsewhere.

Electives		Credits
EGMT 605	**R&D Management I**	3.0

EGMT 606	**R&D Management II**	3.0
EGMT 607	**Marketing for Engineers**	3.0
EGMT 610	**Engineering Ethics & Business Practices for Engineers**	3.0
EGMT 620	**Project Management for Engineers**	3.0
EGMT 625	**Project Planning, Scheduling & Control**	3.0
EGMT 635	**Visual System Mapping for Engineers**	3.0
EGMT 650	**Systems Engineering Leadership**	3.0
EGMT 652	**Engineering Law**	3.0
EGMT 660	**Sustainable Business Practices for Engineers**	3.0
EGMT 685	**Systems Engineering Management**	3.0
EGMT 680	**Special Topics: Systems Engineering Quality**	3.0
EGMT 680	**Special Topics: Preventing Technological Disasters**	3.0

Certificate in Power Engineering Management

18.0 credits

The Certificate in Power Engineering Management is oriented toward engineers in power utilities, utility associations, or infrastructure firms interested in power distribution systems. The scope of this graduate-level program includes both program management and enhancement of technical knowledge beyond a Bachelors degree.

Admission to this graduate certificate program requires an undergraduate degree in engineering. Credits from the certificate can transfer toward either a Masters in Engineering Management or a Masters in Electrical Engineering.

Requirements		18.0 Credits
ECEP 501	**Power System Analysis**	3.0
ECEP 502	**Computer Analysis Power Systems**	3.0
ECEP 503	**Synchronous Machine Modeling**	3.0
ECEP 612	**Economics of Operating Power Systems**	3.0
EGMT 501	**Engineering Management I**	3.0
EGMT 516	**Infrastructure Project & Program Planning**	3.0

Certificate in Engineering Management

12.0 quarter credits

This certificate is awarded to students who successfully complete four graduate-level courses from the MS in Engineering Management curriculum:

Requirements		Credits
EGMT 501	**Engineering Management I**	3.0
EGMT 504	**Communications**	3.0
EGMT 531	**Economics for Engineering Management**	3.0
EGMT 535	**Financial Management I**	3.0

This program is a superb training ground for engineers and scientists who want to get a solid foundation in critical areas in management, finance, and economics without having to commit to the entire graduate program. After completing the program, students have the option of continuing towards a master's degree in Engineering Management.

The program is administered through Drexel eLearning. Applications to the certificate program are managed by Drexel eLearning. For the most current admission information, please visit www.drexel.com.

Master of Engineering

General Information

The Master of Engineering with a practice-oriented manufacturing option, a multidisciplinary program, draws on the strengths of all the departments in the College of Engineering, as well as on the offerings of related areas within the University. Intense global competition has created a demand in American industry for engineering professionals with expertise in modern manufacturing technology, including both the management and physical aspects of manufacturing. The M.E. degree program with a practice-oriented manufacturing option is designed for working professionals and those seeking employment in a manufacturing-related industry.

The M.E. program offers wide flexibility for those students who wish to combine technical and nontechnical study with hands-on experience in industry. It is a career-focused program and may not be appropriate for those whose ultimate goal is a PhD in engineering.

Master of Engineering

Requirements for Admission

In addition to meeting requirements for graduate admission, which include at least a 3.0 GPA for the last two years of undergraduate study and for any graduate study, applicants must hold a bachelor's degree in engineering from an accredited institution or an equivalent. Students whose background is in science or mathematics may be accepted to the program, but they will be required to take undergraduate engineering courses. Although the Graduate Record Examination (GRE) is not required for admission, it may be required of students interested in a teaching or research assistantship. Applicants whose native language is not English and who do not have previous degrees from a U.S. institution are required to submit scores of at least 550 on the Test of English as a Foreign Language (TOEFL).

Master of Engineering

Program of Study
All students enrolled in the program receive the M.E. degree from the College of Engineering. Students take a series of manufacturing core courses, a set of discipline-oriented engineering courses, business core electives, and a mathematics/quantitative methods course. A six-month period of career-related employment through Drexel's Graduate Co-op program is a requirement for full-time students. Students who are already employed as practicing engineers may apply to pursue the program on a part-time basis. A thesis is not required. The average time required to complete the master's degree is two years of full-time study or three years of part-time study.

Degree Requirements
The degree requires a total of 48 credits, including at least 18 credits from an engineering discipline core. This core may be from any engineering department: Civil and Architectural, Chemical, Electrical and Computer, Materials, or Mechanical Engineering and Mechanics. (Please refer to the appropriate departmental description in this catalog for more information about each department.) Students also complete 15 credits from the manufacturing core, which includes 6 credits in manufacturing and 9 credits of departmental manufacturing electives. Three credits of either engineering analysis or probability and statistics, 6 credits from either engineering management or the Bennett S. LeBow College of Business, and 6 credits of GCP round out the program.

Curriculum

Manufacturing core courses		Credits
MEM 687	**Manufacturing Processes I**	3.0
MEM 689	**Computer-Aided Manufacturing**	3.0
	Departmental manufacturing electives (see below)	9.0
	Departmental engineering core	18.0
	Engineering management/business requirements (see below)	6.0
	Engineering analysis/probability and statistics requirement	3.0
	Graduate Co-Op Program	6.0

Departmental Manufacturing Elective Courses

At least three of the following courses must be completed:

Chemical Engineering

Courses		Credits
CHE 525	**Transport Phenomena I**	3.0
CHE 554	**Process Systems Engineering**	3.0
CHE 560	**Transport Phenomena in Biological Systems**	3.0
CHE 562	**Bioreactor Engineering**	3.0
CHE 564	**Unit Operations in Bioprocess Systems**	3.0

Civil Engineering

Courses	Credits

CIVE 673	**Construction Project Management**	3.0
CIVE 674	**Construction Contracting I**	3.0
CIVE 770	**Construction Process Modeling I**	3.0
CIVE 771	**Construction Process Modeling II**	3.0
CIVE 773	**Construction Management**	3.0

Electrical and Computer Engineering

Courses		Credits
ECEC 541	**Robotics/Computer Interface and Controls I**	3.0
ECEC 542	**Robotics/Computer Interface and Controls II**	3.0

Materials Engineering

Courses		Credits
MATE 570	**Materials Processing**	3.0
MATE 651	**Advanced Polymer Processing**	3.0

Mechanical Engineering and Mechanics

Courses		Credits
MEM 688	**Manufacturing Processes II**	3.0
MEM 717	**Heat Transfer in Manufacturing Processes**	3.0
MEM 727	**Fluid Dynamics in Manufacturing Processes**	3.0
MEM 772	**Plasticity in Manufacturing**	3.0
MEM 800	**Special Topics: Concurrent Engineering I**	3.0
MEM 800	**Special Topics: Concurrent Engineering II**	3.0
MEM 800	**Special Topics: Engineering Finite Element Analysis**	3.0

Business Core

At least two of the following courses must be completed:

LeBow College of Business

Courses		Credits
POM 620	**Management of Manufacturing Firms**	3.0
POM 624	**Management of Service Firms**	3.0

Engineering Management

Courses		Credits
EGMT 531	**Economics for Engineering Management**	3.0
EGMT 607	**Marketing for Engineers**	3.0
EGMT 652	**Engineering Law**	3.0
EGMT 680	**Manufacturing Management for Engineers**	3.0

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 and sustainable 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 public health. 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.

For more information about this program, visit the MS in Environmental Engineering web page.

Environmental Engineering

Requirements for Admission

In addition to the general entrance requirements for all Environmental Engineering applicants, entrance to the MS Program in Environmental Engineering requires an undergraduate engineering degree from an ABET-approved institution. Students lacking this credential will be required to complete additional undergraduate courses to incorporate related elements of the functional equivalent of the ABET engineering BS degree. Typically, courses must be taken in computer programming, differential equations, linear algebra and fluid mechanics.

Master of Science in Environmental Engineering

The MS in Environmental Engineering requires 45 credits (thesis option) or 48 credits (non-thesis option). It is possible to finish the MS degree on either a part-time or a full-time basis. The degree consists of five core courses (chemistry, statistics, analysis of physical systems, and policy), completion of sequences in two areas (e.g. water and wastewater, air pollution control, hazardous waste, chemodynamics, assessment, or water resources), additional elective courses and/or the MS thesis. Full time students can complete the degree in 15-18 months.

PhD Program in Environmental Engineering

Applicants to the doctoral program are judged on the basis of academic excellence and the alignment of their research interests with those of the faculty in the School. To be awarded the PhD, students must complete a major research project publishable in peer-reviewed journals. The degree requires a total of 90 credits; credits earned toward a master's degree may apply toward the 90. There is no prescribed coursework—students must take courses needed to complete their research under guidance of an academic advisor. There is a one-year residency requirement. Students must successfully pass the candidacy examination, the proposal defense, and a PhD dissertation and oral defense.

Prospective PhD student are welcome to contact the Department to discuss their research interests.

Materials Science and Engineering

General information
The graduate program in Materials Science and Engineering aims to provide an education which encompasses both the breadth and depth of the most recent knowledge base in the Materials Engineering fields in a format suitable for individuals seeking careers in education and/or industry.

In addition, the program provides students with research training through their course of thesis research at the MS and PhD levels.

The graduate student body reflects a broad spectrum of undergraduate backgrounds. Students with undergraduate degrees in engineering fields other than materials science are encouraged to take selected undergraduate courses in materials. Because of the expansion into interdisciplinary areas, qualified physical and biological science graduates may also join the program. Non-engineering graduates, however, must take an appropriate number of undergraduate engineering courses to supplement their background.

Graduate work in materials science and engineering is offered both on a regular full-time basis and on a part-time basis. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

A graduate seminar is required of all graduate students in the department. The seminar, which should be completed during the first year of a student's studies, consists of an oral presentation based on a completed literature review of topics closely related to the student's potential research area.

Career Opportunities
Graduates go on to careers in engineering firms, consulting firms, private industry, research laboratories, academia, and government. Materials scientists and materials engineers find employment in such organizations as Hewlett-Packard, Intel, IBM, 3M, Lockheed-Martin, Johnson, Merck, AstraZeneca, Arkema, ARL, National Laboratories, Air Products, Micron, Xerox, Motorola, Monsanto, Corning, Eastman Kodak and DuPont.

For more information about Materials Engineering, visit the Department of Materials Science and Engineering web page.

Materials Engineering

Requirements for Admission
Applicants must meet the graduate requirements for admission to Drexel University. The graduate student body reflects a broad spectrum of undergraduate backgrounds. Because of the expansion into interdisciplinary areas, qualified physical and biological science graduates may also join the program. However, non-engineering graduates must take an appropriate number of undergraduate engineering courses to supplement their background.

Master of Science in Materials Science and Engineering

A total of 45 credits are required for the MS degree. These include two required core courses on the structure and properties of solids, and the thermodynamics of solids.

A 3-credit course from the Department of Mathematics and Computer Science or the course in numerical methods (MATE 580), offered by the Department of Materials Engineering, fulfills the math requirement.

All full-time students are required to undertake a 9-credit thesis on a topic of materials research supervised by a faculty member and to submit a plan of study during their first year of the program. Part-time graduate students are encouraged to undertake a research thesis, but if this is not possible, a faculty-supervised 6-credit literature survey (including a research proposal) is required.

All students are required, during their first year, to propose and submit an advisor-supported research thesis topic or literature survey for approval by the department. Students are urged to select a topic as early as possible and to choose appropriate graduate courses in consultation with their advisor. Both the research thesis and literature survey are subject to an oral examination before the MS degree is awarded.

The program is organized so that part-time students may complete the degree requirements in two to four years. Full-time students may complete the program in two years.

PhD in Materials Science and Engineering

The graduate school requires at least 90 credits for the PhD degree in Materials Science and Engineering. An MS degree is not a prerequisite for the PhD degree, but does count as 45 credits toward the 90-credit requirement. No additional courses are required for students entering the department with an approved MS degree. Students entering the department at the BS level must satisfy the course requirements for the MS degree.

Students choose a doctoral thesis topic after consultation with the faculty. Students are urged to consider and select topics early in their program of study. An oral thesis presentation and defense are scheduled at the completion of the thesis work.

Doctoral program students must pass a candidacy examination. The candidacy exam is usually given at the end of the student's first year of graduate study, and consists of a seminar presentation by the student, followed by an oral examination covering the materials core course as well as the subject matter presented in the seminar. Doctoral candidates should prepare and present (a) a PhD thesis proposal within two years of entering the program, and (b) a pre-defense seminar approximately six-months before the full defense of their PhD thesis.

For more information, visit the Department of Materials Science and Engineering web page.

Mechanical Engineering and Mechanics

General Information
The field of mechanical engineering is rapidly changing due to advances in materials, manufacturing, and communication. Mechanical engineers must possess diverse interdisciplinary skills, including an understanding of the global, entrepreneurial and managerial abilities, and teamwork skills.

The Mechanical Engineering and Mechanics (MEM) Department offers Graduate work is offered on both a full-time and a part-time basis. The majority of courses are scheduled in the late afternoon and evening, so part-time students can take courses together with full-time students. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

The department has adopted the Graduate Co-op program at the master's level.

Mechanical Engineering and Mechanics

Requirements for Admission
Applicants must meet the graduate requirements for admission to Drexel University. Students holding a bachelor's degree in a science or engineering discipline other than mechanical engineering are advised to take several undergraduate courses as preparation for graduate studies. Though these courses are not counted toward the required credits for the degree, they also must be listed in the student's plan of study. Outstanding students with a GPA of at least 3.5 in their master’s program will be considered for admission to the program leading to the doctor of philosophy degree in mechanical engineering.

Master of Science Program in Mechanical Engineering

The MS program has a two-fold mission: to prepare some students for continuation of their graduate studies and research toward a PhD degree and to provide other students with a terminal professional degree to better prepare them for a career in industry.

The MS program is structured so that students have the opportunity to specialize in an area of interest while obtaining the broadest education possible.

MS candidates are required to take two core-course sequences (two terms each) from any two core areas. Candidates may choose either the thesis or nonthesis option; all MS students are strongly recommended to follow the thesis option.

Typical MS program

	Two core-course sequences (required)	12.0
	Three mathematics* courses (required)	9.0
	Eight technical electives (including 9 credits for thesis option)	24.0

***Mathematics courses:**

MEM 591	**Applied Engineering Analysis Methods I**	3.0
MEM 592	**Applied Engineering Analysis Methods II**	3.0
MEM 593	**Applied Engineering Analysis Methods III**	3.0

Core Areas

All students take core courses in the department's areas of specialization as part of a comprehensive and flexible program. Further details can be obtained from the department's Graduate Programs Manual.

The core courses in each area are listed below:

Mechanics Area

Theory of elasticity

MEM 660	**Theory of Elasticity I**	3.0
MEM 661	**Theory of Elasticity II**	3.0

Solid mechanics

MEM 663	**Foundations of Solid Mechanics**	3.0
MEM 664	**Introduction to Plasticity**	3.0

Advanced dynamics

MEM 666	**Advanced Dynamics I**	3.0
MEM 667	**Advanced Dynamics II**	3.0

Systems and Control Area

Robust control systems

MEM 633	**Robust Control Systems I**	3.0
MEM 634	**Robust Control Systems II**	3.0

Non-linear control theory

MEM 636	**Theory of Nonlinear Control I**	3.0
MEM 637	**Theory of Nonlinear Control II**	3.0

Real-time microcomputer control

MEM 639	**Real-Time Microcomputer Control I**	3.0
MEM 640	**Real-Time Microcomputer Control II**	3.0

Thermal and Fluid Sciences Area

Advanced thermodynamics*

MEM 601	**Statistical Thermodynamics I**	3.0
MEM 602	**Statistical Thermodynamics II**	3.0

Heat transfer

MEM 611	**Conduction Heat Transfer**	3.0
MEM 612	**Convection Heat Transfer**	
or		
MEM 613	**Radiation Heat Transfer**	3.0

Fluid mechanics*

MEM 621	**Foundations of Fluid Mechanics**	3.0
MEM 622	**Boundary Layers: Laminar and Turbulent**	3.0

***Consult the Thermal and Fluid Sciences area advisor for other options.**

Doctoral Program in Mechanical Engineering

Outstanding students with a GPA of at least 3.5 in their master's program will be considered for admission to the program leading to the Doctor of Philosophy degree in mechanical engineering.

At least 90 credits are required for the PhD degree. The master's degree is not a prerequisite for the PhD, but does count as 45 credits toward the 90-credit requirement. In addition to the 45 credits normally taken for the MS degree, students must take at least 18 credits of coursework (exclusive of independent study or thesis credits). The remaining 27 credits consist of a combination of dissertation, independent study, and additional advanced coursework consistent with the approved plan of study. All PhD students are expected to participate in the department's seminar program, course instruction, and other academic activities.

Students who hold a BS degree and are currently enrolled in the MEM graduate program can take the PhD candidacy examination after the completion of at least one year of graduate study at Drexel University with a minimum GPA of 3.5 in all engineering and science graduate courses. A student holding an MS degree that has not been granted by the MEM Department can take the PhD candidacy examination after completing at least two terms of graduate study at Drexel University with a minimum GPA of 3.5 in all engineering and science graduate courses taken while in the MEM Department.

The PhD candidacy examination consists of two parts, a written part and an oral part. The written part consists of one examination in applied mathematics and one examination in a major area established by the applicant and his or her advisor. Following successful completion of the written examinations, an oral examination is administered. This examination emphasizes, but is not restricted to, the student's major area.

The PhD candidacy examination is given twice each year, at the beginning of the fall and spring terms. Additional details are given in the Mechanical Engineering and Mechanics Graduate Program Manual.

At least one year prior to graduation, candidates must give a presentation to the dissertation committee. The committee must approve the thesis topic and the general method of attack. A final examination consisting of a presentation and defense of the research dissertation is required, before the PhD degree is granted.

Furthermore, PhD students may have to take technical writing courses in fulfillment of their PhD requirements. Foreign PhD students are subject to the same ESL requirements as MS students.

PhD students must comply with the University's one-year residency requirement.

Further details can be obtained from the department's Graduate Programs Manual.

Master of Science in Software Engineering

Drexel University's Master of Science in Software Engineering (MSSE) degree program was created in response to the growing importance of software to the national infrastructure and the rapid rise in demand for professional software engineers.

All students in the MSSE program take a core curriculum that spans the scope of disciplinary areas relevant to the degree, thereby providing a common foundation for all students in the program. Students also elect an area of concentration, or track — a cohesive, more specialized set of courses that builds on the core to support each student's particular career interest. Three tracks are available: information science and technology, computer science, and engineering. Students in all tracks are encouraged to participate in Drexel's Graduate Co-op Program if they do not have prior or current work experience. The average time to complete this master's degree is three years of part-time study.

Master of Science in Software Engineering

Admissions Requirements
In addition to satisfying the general admission requirements of the University, all applicants to the program must satisfy the following entrance requirements:

- Applicants must have a bachelor's degree from an accredited institution of higher education with an appropriate undergraduate major. Appropriate undergraduate majors include, but are not limited to, computer science, engineering, information systems, management science, and mathematics. Applicants may also have master's degrees in similar fields.
- The GRE General (Aptitude) Test is required for all applicants pursuing full-time study on the engineering and computer science tracks. MSSE applicants for the information science and technology track with a cumulative GPA of 3.2 or higher (on a 4.0 grade scale) in any completed degree, bachelor's or above and applicants with a "half cum" of 3.2 or higher (on a 4.0 grade scale) in any completed degree, bachelor's or above may be eligible for admission to the master's program without taking the GRE.
- After consultation with an academic advisor, students found to be deficient in one or more of the areas below will be required to take foundation courses (these will not count toward the degree) to prepare them for admission to the MSSE program. These foundation courses, to be determined by the advisor, will provide students with the requisite knowledge and skill necessary to begin the master's program. Foundation courses must be taken at Drexel or another approved university.
- Applicants should possess the following knowledge and/or experience:
    - Advanced capability to program in a block-structured programming language such as Pascal, C, or Ada, or an object-oriented language such as C++ or Smalltalk.
    - A grade of B or better in an undergraduate course in systems analysis and design or software engineering.
    - A grade of B or better in an undergraduate course in data structures and algorithms.
    - A grade of B or better in an undergraduate course in discrete mathematics.
    - Applicants must demonstrate evidence of an understanding of the development of industrial-strength software applications. This requirement may be met by at least two years of experience working directly with software system development, or (with permission of an advisor) by extensive software-intensive coursework. Students may also be required to have or develop proficiency in particular technologies, operating systems, or programming languages.

Master of Science in Software Engineering

Degree Requirements
Degree requirements vary by track. All students take the required six core courses (18 credits).

Core Courses
Core courses cover topics that are essential for the practicing software engineer.

Core Courses		**18.0 Credits**
Computer science courses		
CS 575	**Software Design**	3.0
CS 576	**Dependable Software Systems**	3.0
Electrical and computer engineering courses		
ECEC 500	**Fundamentals of Computer Hardware**	3.0
ECEC 600	**Fundamentals of Computer Networks**	3.0
Information science and technology courses		
INFO 627	**Requirements Engineering and Management**	3.0
INFO 638	**Software Project Management**	3.0

Tracks
Students in each track follow the policies determined by the respective College.

Information Science and Technology Track
Track Coordinator:
Dr. Eileen Abels, 215-895-6274, eabels@drexel.edu

This track supports students interested in applying software engineering to information systems problems in commercial organizations and other settings. The principal focus is the process by which user and system requirements are converted into cost-effective, maintainable software systems. This is complemented by a concern for defining, creating, understanding, and evaluating the full range of software life-cycle products. The track places particular emphasis on information systems methodologies such as human-computer interaction, requirements analysis, modeling, and validation, along with the use of off-the-shelf tools and components to assist in software processes.

Students in the information science and technology track take a total of nine track courses: four required track courses, three courses selected from the track distribution courses, and two courses selected from the distribution courses or other approved electives. This track requires a total of 45 credits, 18 of which are from the required core. The Graduate Co-op program (GCP) is available for up to six credits which do not count toward graduation. Hence, the GCP option requires students to take six credits more than the non-GCP option.

Required courses	**12.0**

		Credits
INFO 608	**Human-Computer Interaction**	3.0
INFO 630	**Evaluation of Information Systems**	3.0
INFO 636	**Software Engineering Process I**	3.0
INFO 637	**Software Engineering Process II**	3.0

Distribution courses		**9.0 Credits**
INFO 606	**Advanced Database Management**	3.0
INFO 607	**Applied Database Technologies**	3.0
INFO 610	**Analysis of Interactive Systems**	3.0
INFO 611	**Design of Interactive Systems**	3.0
INFO 620	**Information Systems Analysis and Design**	3.0
INFO 631	**Information Technology Integration**	3.0
INFO 646	**Information Systems Management**	3.0

Two Elective courses		**6.0 Credits**
INFO 612	**Knowledge Base Systems**	3.0
INFO 613	**XML and Databases**	3.0
INFO 616	**Computer-Supported Cooperative Work**	3.0
INFO 617	**Introduction to System Dynamics**	3.0
INFO 634	**Data Mining**	3.0
INFO 780	**Special Topics**	3.0

Computer Science Track

Track Coordinator: Dr. Spiros Mancoridis, 215-895-6824, spiros@drexel.edu

The computer science track welcomes students who are interested in a variety of technical topics pertaining to the development of software systems such as databases, networks, operating systems, graphics and animation systems, compilers, expert systems, and systems for scientific computing. Students will use languages and apply techniques to specify, design, implement, test, and maintain software systems.

Students in the computer science track take 9 courses in addition to the 6 core courses. Of the 9 courses, 4 courses must be from one of the six concentrations. The other 5 courses are electives that may be fulfilled by any course offered for the MSSE degree.

Students in their final 3 quarters of study who have a 3.5 GPA or better may take a 9-credit project instead of 3 elective courses. To register for a project, the student must select a project advisor (a member of the CS faculty who is willing to supervise). The project is a large-scale software development effort in which students specify, design, implement, and test a significant software system.

The Graduate Co-op program (GCP) is also available for up to 6 credits. Hence, the GCP option requires students to take 6 credits more than the non-GCP option.

Concentration courses		**Credits**
Computing systems concentration		
CS 543	**Operating Systems**	3.0
CS 643	**Advanced Operating Systems**	3.0
CS 544	**Computer Networks**	3.0
CS 741	**Computer Networks II**	3.0
CS 645	**Cryptography and Network Security**	3.0
CS 675	**Software Reverse Engineering**	3.0

Programming languages concentration		
CS 525	**Theory of Computation**	3.0
CS 550	**Programming Languages**	3.0
CS 551	**Compiler Construction I**	3.0
CS 552	**Compiler Construction II**	3.0
CS 675	**Software Reverse Engineering**	3.0
CS 680	**Special Topics in Computer Science: Program Generation and Optimization**	3.0

User interface software concentration		
CS 536	**Computer Graphics**	3.0
CS 636	**Advanced Computer Graphics**	3.0
CS 530	**Developing User Interfaces**	3.0
CS 630	**Cognitive Systems**	3.0
CS 680	**Special Topics in Computer Science: Game Design and Implementation**	3.0
PSY 612	**Psychology of Human-Computer Interaction Design**	3.0

Artificial intelligence concentration		
CS 510	**Artificial Intelligence**	3.0
CS 610	**Advanced Artificial Intelligence**	3.0
CS 612	**Knowledge-Based Agents**	3.0
CS 511	**Robot Building Laboratory**	3.0

Scientific computation concentration		
CS 668	**Computer Algebra I**	3.0
CS 669	**Computer Algebra II**	3.0
CS 680	**Special Topics in Computer Science: Methods I**	3.0
CS 680	**Special Topics in Computer Science: Methods II**	3.0
CS 540	**High Performance Computing**	3.0
CS 567	**Applied Symbolic Computing**	3.0
CS 676	**Parallel Programming**	3.0

For additional information on the Computer Science Track, as well as an FAQ, visit the Department of Computer Science's Master of Science in Software Engineering web page.

Engineering Track
T*rack Coordinator: Dr. Kapil Dandekar, 215-571-3579, dandekar@ece.drexel.edu*

Students in this track pursue techniques to model engineering problems and offer software solutions. The courses in this track emphasize problems facing engineering industries including electrical, mechanical, environmental, chemical, and others. Systems modeling and simulation techniques will be used to solve these problems.

Students in this track take 27 or more credits of track courses in addition to the 18 credits of required core courses. Three computer engineering courses are required; the other courses are from one of five concentrations. A total of 45 approved graduate credits are required for the MSSE, including the 18 credits of core courses. Students opting for the Graduate Co-op Program (GCP) option are required to complete 51 approved credits, including 6 GCP credits.

For more information on curriculum requirements, visit the Department of Electrical and Computer Engineering's Graduate Student Guide.

Courses	Credits

ECEC 511	**Issues in Combinational Circuit Design**	3.0
ECEC 512	**Issues in Sequential Circuit Design**	3.0
ECEC 513	**Design for Testability**	3.0

Chemical engineering concentration

CHE 554	**Process Systems Engineering**	3.0
CHE 658	**Advanced Process Design**	3.0

Civil and architectural engineering concentration

CIVE 501	**Model Analysis of Structures**	3.0
CIVE 605	**Advanced Mechanics of Materials**	3.0
CIVE 701	**Structural Analysis I**	3.0
CIVE 702	**Structural Analysis II**	3.0
CIVE 703	**Structural Analysis III**	3.0
CIVE 704	**Behavior and Stability of Structural Members I**	3.0

Electrical and computer engineering concentration

ECEC 621	**High Performance Computer Architecture**	3.0
ECEC 622	**Parallel Computer Architecture**	3.0
ECEC 623	**Advanced Parallel Computer Architecture**	3.0

NOTE: Any other ECE 500-level or above course may be eligible for credit for the Electrical and Computer Engineering concentration.

Materials engineering concentration

MATE 605	**Computer Simulation of Materials and Processes I**	3.0
MATE 606	**Computer Simulation of Materials and Processes II**	3.0
MATE 670	**Materials Processing I**	3.0
MATE 671	**Materials Processing II**	3.0

Mechanical engineering and mechanics concentration

MEM 534	**Discrete Time Control and Estimation I**	3.0
MEM 535	**Discrete Time Control and Estimation II**	3.0
MEM 536	**Microcomputer-Based Control of Dynamic Systems I**	3.0
MEM 537	**Microcomputer-Based Control of Dynamic Systems II**	3.0
MEM 574	**Introduction to CAM**	3.0
MEM 534	**Reliability of Mechanical Systems I**	3.0
MEM 677	**Reliability of Mechanical Systems II**	3.0
MEM 678	**Reliability of Mechanical Systems III**	3.0
MEM 681	**Finite Element Methods I**	3.0
MEM 682	**Finite Element Methods II**	3.0
MEM 683	**Finite Element Methods III**	3.0

MS in Electrical Engineering/Telecommunications Engineering

General Information

Fueled by the rapid spread of technologies such as electronic mail, cellular and mobile phone systems, interactive cable television, and the information superhighway, Drexel's program in Telecommunications Engineering responds to the growing demand for engineers with telecommunications expertise.

Drexel University's program in Telecommunications Engineering combines the expertise of its faculty in Electrical and Computer Engineering, Business, Information Systems, and Humanities. The program combines a strong foundation in telecommunications engineering with training in other important areas such as global communications, business aspects of telecommunications, and information transfer and processing. Through its interdisciplinary approach, Drexel's Telecommunications Engineering program trains and nurtures the complete telecommunications engineer.

Program of Study

The MSEE/Telecommunications Engineering degree is awarded to students who demonstrate in-depth knowledge of the field. AThe average time required to complete the master's degree is two year of full-time or three years of part-time study.

For more information, visit thevisit the Department of Electrical and Computer Engineering’s web site.

MS in Electrical Engineering/Telecommunications Engineering

Requirements for Admission

Applicants must meet the general requirements for graduate admission, which include at least a 3.0 GPA for the last two years of undergraduate study and for any graduate level study undertaken, and are required to hold a bachelor of science degree in electrical engineering or a related field. Applicants whose undergraduate degrees are not in the field of electrical engineering may be required to take a number of undergraduate courses. The GRE General Test is required of applicants for full-time MS and PhD programs. Applicants whose native language is not English and who do not have a previous degree from a U.S. institution are required to take the Test of English as a Foreign Language (TOEFL).

MS in Electrical Engineering/Telecommunications Engineering

Plan of Study
For this program, a plan of study, with appropriate telecommunications-related technical content (as outlined below) must be approved by the graduate advisor, in consultation with the student's research advisor (if applicable). Full time students must file a plan of study with the graduate advisor before the end of the first quarter. Part-time students must file a plan of study with the graduate advisor by the end of the first year. The Plan of Study form is available at:

http://www.ece.drexel.edu/grad/plan_of_study_form.pdf

Degree Requirements
The MS Electrical Engineering/Telecommunications Engineering curriculum encompasses 45.0 or 48.0 (with the Graduate Co-op option) credits.

A total of at least 30.0 credits of graduate courses are required from the Electrical and Computer Engineering department. With the remaining graduate credits, subject to the approval of the graduate advisor, students can take graduate course from electrical and computer engineering, mathematics, physics or other engineering disciplines. Students may also elect to take three credits in Telecommunications Policy and/or three credits in Telecommunications Management.

Students also may chose to complete a three credit project, which can either be theoretical or experimental, or to participate in six credits (6 months) of Graduate Co-op.

For more information, visit the Department of Electrical and Computer Engineering's web site.

Electrical and Computer Engineering Courses

Students select a minimum of 10 of the following courses:		**30.0 Credits**
ECEC 631	**Principles of Computer Networking**	3.0
ECEC 632	**Performance Analysis of Computer Networks**	3.0
ECEC 633	**Advanced Topics in Computer Networking**	3.0
ECES 511	**Fundamentals of Systems I**	3.0
ECES 512	**Fundamentals of Systems II**	3.0
ECES 513	**Fundamentals of Systems III**	3.0
ECES 521	**Probability and Random Variables**	3.0
ECES 522	**Random Process and Spectral Analysis**	3.0
ECES 523	**Detection and Estimation Theory**	3.0
ECES 631	**Fundamentals of Deterministic DSP**	3.0
ECES 632	**Fundamentals of Statistical DSP**	3.0
ECES 682	**Fundamentals of Image Processing**	3.0

Non-Engineering:

The following course dealing with the business and legal aspects of telecommunications is strongly recommended to students pursuing the major:

COM 650	**Telecommunications Policy**	3.0

Suggested Electives

The following list contains some suggested electives from the graduate offerings in the Electrical & Computer Engineering Department. These courses allow students to choose specific focus are (for example, Microwave Systems, Signal Processing, Photonics Systems, Networking, etc.) depending on their career goals.

ECES 558	**Digital Signal Processing for Sound & Hearing**	3.0
ECES 559	**Processing of the Human Voice**	3.0
ECES 660	**Machine Listening and Music Information Retrieval**	3.0
ECEE 517	**Microwave Networks and Transmission Media**	3.0
ECEE 641	**Fiber Optics and Optical Communications I**	3.0
ECEE 522	**Photonic Devices**	3.0
ECEC 661	**VLSI Design**	3.0
ECEC 631	**Principles of Computer Networking**	3.0

Students may also choose other elective courses from the ECE graduate offerings and graduate offerings from the departments of Mathematics and Physics and the College of Engineering.

Please note that ECEC 500 and ECEC 600 will not count towards the required courses for the degree in MS in Electrical Engineering/Telecommunications Engineering.