Drexel University Catalog 2002 2003

Graduate Catalog

Drexel University
Catalog 2002 2003

The College of Arts and Sciences

The College of Arts and Sciences offers graduate curricula leading to the Master of Science degree in the following:

- Bioscience and Biotechnology
- Chemistry
- Communication
- Computational Mathematics
- Computer Science
- Environmental Policy
- Environmental Science
- Mathematics
- Nutrition and Food Science
- Physics
- Psychology
- Publication Management
- Science, Technology, and Society

The College of Arts and Sciences also offers the graduate curricula leading to the Doctor of Philosophy degree in the following:

- Bioscience and Biotechnology
- Chemistry
- Mathematics
- Nutrition and Food Science
- Physics
- Psychology

The English Language Center
As part of the College of Arts and Sciences, Drexel's English Language Center offers an intensive English program throughout the year. Besides classes in academic skills such as essay writing and oral presentations, the center offers courses in business English, English for academic purposes, computer skills in English, TOEFL preparation, and other subjects. Many graduate students begin their studies at Drexel in the English Language Center, particularly if they do not meet minimum TOEFL requirements (see the Special Language Enhancement Program, described below).

Interested applicants may call the English Language Center at 215-895-2022; fax: 215-895-6775; e-mail:elc@ drexel.edu.

The Special Language Enhancement Program
Students who have good academic qualifications but whose TOEFL scores are below the minimum required by their department may be accepted to Drexel through the Special Language Enhancement Program (SLEP). SLEP students will be provided a program that includes English language study, Drexel courses, and academic advising

Bioscience and Biotechnology

General Information

Graduate programs in the Department of Bioscience and Biotechnology are designed to provide opportunities for intensive, individualized study and research in molecular biology, ecology, and biological sciences. Department research programs emphasize molecular genetics and genetic engineering, including gene cloning, recombinant DNA technology, and vectors for transferring recombinant DNA. Other programs include gene regulation during development, membrane biochemistry, molecular biology of bacteria and plants, environmental physiology, biophysical and physiological ecology, and the impact of ecological changes in the environment due to man. Opportunities are available for quantitative experiments and field studies on the bioenergetics of reptiles and amphibians, and the biology of sea turtles. Students may also examine growth and scale-up conditions for microorganisms and eucaryotic cells (including genetically engineered cells) through cooperative research with biochemical engineering faculty. Additional projects may be arranged with associated faculty in the School of Biomedical Engineering, Science, and Health Systems and the School of Environmental Science, Engineering, and Policy; these include areas such as environmental microbiology and neural physiology.

The graduate program for each student is designed to accommodate individual career goals, although all students are required to take Research Methods in Applied Nutrition (NFS 601) and one course in each of the areas of biochemistry, evolution, and genetics. All thesis M.S. and Ph.D. students must take graduate seminar once per year.

Teaching assistantships, research assistantships, and other forms of financial aid are available.

Master of Science Program

Forty-five credits are required for the M.S. in Biological Sciences. Soon after matriculation the student formulates a plan of study with the advisor, outlining his or her specific program, and completes the qualifying examination. Both thesis and nonthesis options are available, although some formal research activity is recommended for all M.S. degree candidates. Students wishing to pursue Ph.D. candidacy are encouraged to elect the M.S. with thesis. After all other requirements are completed, the research M.S. student defends the thesis at a final oral examination. The nonthesis student takes a comprehensive examination.

The M.S. candidate may simultaneously obtain secondary education certification by including specified required courses. The minimum number of credits for this M. S. degree is 48.

Doctoral Program

The Doctor of Philosophy in Biological Sciences is conferred in recognition of breadth of scholarship and scientific attainment plus demonstrated ability to complete original research. A minimum of 90 credits is required beyond the bachelor’s degree. In addition to a qualifying examination, the Ph.D. student must pass a candidacy examination and an oral defense of his or her dissertation, which

demonstrates the capacity to perform independent research. Both examinations are administered by the student's examining committee.

Faculty Research Interests

Shivanthi Anandan, Ph.D. *(University of California, Los Angeles), Assistant Professor*
Microbial genetics, in particular the analysis of light-regulated signal transduction pathways and the regulation of gene expression in photosynthesizing organisms.

Joseph E. Bentz, Ph.D. *(State University of New York), Professor*
Biophysics and biochemistry, molecular basis of biological membrane fusion.

Cecilie Goodrich, Ph.D. *(Harvard University), Professor*
Neuroscience and systems physiology, postnatal maturation of physiology and behavior in relation to brain immunocytochemistry.

Kylie Keshav, Ph.D. *(University of Wallengong, Australia), Assistant Professor*
Impact of environmental mutagens and carcinogens on DNA replication, perturbations in DNA replication and DNA in tumorigenic cells, utilization of waste products for bioenergy productions.

Mark S. Lechner, Ph.D. *(University of Chicago), Assistant Professor*
Regulation of eukaryotic gene expression through chromatin-organizing proteins.

Jeremy Lee, Ph.D. *(University of California at Berkeley), Assistant Professor*
Molecular mechanisms underlying interactions between muscles, neurons and the epidermis; functional roles of neurotransmitter receptors.

Albert List, Jr., Ph.D. *(Cornell University), Professor Emeritus*
Botany and ecology, changes in vegetation produced by man's activities in forests, establishment of base data on vegetation composition and environmental characteristics, development of stereophotometric and digital conversion techniques to be used in ecological research.

Wayne E. Magee, Ph.D. *(University of Wisconsin), Professor Emeritus*
Biochemistry and microbiology, drug delivery using phospholipid vesicles, membrane-membrane interactions, hybridoma research for monoclonal antibody production, immunotherapy, biochemical virology.

Michael O'Connor, *M.D. (Johns Hopkins University), Ph.D. (Colorado State), Associate Professor*
Biophysical and physiological ecology, thermoregulation of vertebrates, ecological modeling.

Peter M. Oelkers, Ph.D. *(Wake Forest University), Assistant Professor*
Triglyceride metabolism in S. cerevisia and the interaction of triglyceride and phospholipid metabolism.

Facilities

Centrifuges
These range from tabletop models to ultracentrifuges.

Computers
Both dedicated and general-use computers are used for data acquisition and analysis in all areas of biological research, from field studies of botanical species to the study of recombinant DNA plasmids.

Culture Facilities
For the growth and handling of microorganisms and mammalian cells, these facilities include numerous incubators, shaking incubators, bioreactors, biological safety cabinets, growth chambers, and a greenhouse.

Gas Liquid Chromatograph-Mass Spectrometer
This is available in conjunction with the Department of Chemistry for the analysis of biological molecules.

Gas Liquid Chromatographs
Several models are currently in use for the quantitative analysis of biological macromolecules.

High-Performance Liquid Chromatographs
Several models, both analytical and preparative, are available for the rapid separation of biological molecules.

Microscopes
Light field, phase contrast, and fluorescent microscopes are available for the analysis of eucaryotic cells and tissues and examination of microorganisms.

Scintillation Counters
These are available for the determination of radioisotope incorporation into or utilization by organisms or other constituents.

Spectrophotometers
Available for analysis of compounds by absorption of ultraviolet and visible light, these include several microprocessor-controlled models that are capable of wavelength scanning, enzyme kinetic analysis, and scanning of gels and autoradiograms.

Chemistry

General Information

The Chemistry Department offers graduate programs in analytical chemistry, inorganic chemistry, organic chemistry, physical chemistry, and polymer chemistry. The department also encourages interdisciplinary activities. Faculty members are active participants in the environmental engineering and science and biomedical science and engineering programs; others work with physicists and biologists in areas such as atmospheric science, biochemistry, and biophysical chemistry.

The chemistry faculty wants graduate students to understand the purpose of, and need for, fundamental research while working on problems of practical interest and application to the challenges facing mankind in the modern world. Areas of research include the use of digital electronic methods to analyze trace constituents of air and water, a study of the molecules of living systems, the effects of toxic chemicals and carcinogens, synthesis and characterization of compounds of medicinal and industrial interest, methods for studying macromolecules, and characterization of transient species using lasers.

The Chemistry Department strives to maintain a community of research scholars (faculty, postdoctoral fellows, and graduate and undergraduate students) that is large enough to provide a variety of experiences within chemistry, yet small enough to give each student individual attention. Both full- and part-time study are available.

A detailed description of programs is given in the departmental brochure "Graduate Studies in Chemistry."

For admission to graduate study, the department requires a B.S. in chemistry or the equivalent. This requirement applies to full-time and part-time students working toward either the M.S. or the Ph.D. degree. All entering M.S. and Ph.D. students are required to take a series of two-hour exams in analytical, inorganic, organic, and physical chemistry to help assess their preparation for graduate work in chemistry. The scores obtained on these exams are used as a basis for course selection.

Financial Assistance

Graduate students at Drexel can obtain two main types of financial support: teaching assistantships and research assistantships. Teaching assistantships are available on a competitive basis to incoming students and are normally renewable for several years.

Master of Science Program

The M.S. degree is awarded after satisfactory completion of a minimum of 45 credit hours in chemistry and related fields, at least 30 credits of which must be taken at Drexel. Both thesis and nonthesis options are available.

Course Requirements

The course requirements for both thesis and nonthesis options are one complete sequence in the major area of interest; one of the sequence courses from each of analytical, organic, polymer, and inorganic chemistry; and two courses in physical chemistry. The remaining credits may be chosen from graduate courses within the department or from other departments offering courses related to the student’s major areas.

Courses		Credits
Major sequence (choose one of the following)		**9.0**
CHEM 521	**Inorganic Chemistry I**	
CHEM 522	**Inorganic Chemistry II**	
CHEM 523	**Inorganic Chemistry III**	
or		
CHEM 530	**Analytical Chemistry I**	
CHEM 531	**Analytical Chemistry II**	
CHEM 532	**Analytical Chemistry III**	
or		
CHEM 541	**Organic Chemistry I**	
CHEM 542	**Organic Chemistry II**	
CHEM 543	**Organic Chemistry III**	
or		
CHEM 557	**Physical Chemistry I**	
CHEM 558	**Physical Chemistry II**	
CHEM 659	**Physical Chemistry III**	
or		
CHEM 561	**Polymer Chemistry I**	
CHEM 562	**Polymer Chemistry II**	
CHEM 563	**Polymer Chemistry III**	
CHEM 665	**Topical Group**	1.0
CHEM 865	**Research Seminar**	3.0
	Additional sequence courses*	15.0
	Electives	17.0

***One of which must be chosen from the following: CHEM 555 (Quantum Chemistry of Molecules I), CHEM 557 (Physical Chemistry I), CHEM 561 (Polymer Chemistry I), CHEM 562 (Polymer Chemistry II), or CHEM 563 (Polymer Chemistry III).**

Thesis Option

Up to 9 credits of coursework may be replaced by either CHEM 997 or by sections of CHEM 680 involving laboratory research. No later than the spring term of the first year of coursework, a student should choose a research advisor with whom to work in carrying out an original investigation in chemistry. The results will be written up in thesis form and submitted to an M.S. thesis committee consisting of the research advisor and two other departmental faculty appointed by the advisor. The acceptance by this committee of the M.S. thesis completes the thesis option requirements for the M.S. degree. Students in the M.S. program receiving financial aid from the department must elect the thesis option if they do not pursue the Ph.D. program at Drexel.

Doctoral Program

The Ph.D. degree is awarded in any of five main areas of chemistry: analytical, inorganic, organic, physical, or polymer chemistry. The degree recipient must demonstrate scholastic breadth in chemistry and contribute significantly to scientific advancement in a chosen major area. Requirements of the program include coursework, candidacy examinations, a chemical information retrieval or technical writing course, and successful completion of a publishable Ph.D. thesis.

Course Requirements

Ninety credits of graduate-level work must be completed for the Ph.D. degree. The Chemistry Department requires 30 credits of coursework in chemistry (outlined

above in the Course Requirements section of the M.S. program). The balance can be made up of more advanced special topics courses and research credits.

Candidacy Requirements
To become a candidate for the Ph.D. in chemistry at Drexel, a student must pass a prescribed set of cumulative examinations and present and successfully defend a research proposal in an area not directly related to his or her Ph.D. thesis research.

Cumulative Examinations
Written examinations designed to test a student's background in his or her major area are given monthly during the academic year and occasionally during the summer at the discretion of the faculty. Students should begin taking these examinations after having completed three courses in the major area (usually the main sequence courses). Full-time students normally begin taking these examinations in the fall term of their second year.

Research Proposal
The research proposal is an attempt to confront the student early on with the problem of defining and evaluating a worthwhile research program. The examination at which the research proposal is defended is held no later than 90 days after the notification of a student's completion of the cumulative examination requirement. A written proposal is submitted to the committee no later than two weeks before the examination. A passing grade on this examination admits the student to Ph.D. candidacy.

Thesis
A Ph.D. thesis — the heart of the Ph.D. degree — must be written, accepted by the research supervisor, presented to a Ph.D. Thesis Examining Committee, and defended orally. It is the responsibility of the student, not the research supervisor, to submit an acceptable thesis.

Faculty Research Interests
Anthony W. Addison, Ph.D. *(University of Kent at Canterbury, England), Professor*
Bioinorganic chemistry: chemistry of oxygen-binding metalloproteins, synthesis and chemistry of inorganic complexes as models for oxygen-transporting and redox protein metal centers, redox chemistry of organic and inorganic molecules and magnetically coupled systems.

Alan R. Bandy, Ph.D. *(University of Florida), R. S. Hanson Professor of Atmospheric Chemistry*
Atmospheric and analytical chemistry: chemistry of trace reduced sulfur and hydrocarbon compounds in the atmosphere, relationship between naturally emitted hydrocarbons and photochemical oxidation formation. Computational chemistry of sulfur oxides.

Jean-Claude Bradley, Ph.D. *(University of Ottawa, Canada), Assistant Professor*
Modification and functionalization of colloidal particles and vesicles in a toposelective manner to generate toposomes; programmed self-assembly of colloids; electric field effects on colloidal and other chemical systems; generation of metallic microstructures by electric fields; gene therapy.

Joseph P. Foley, Ph.D. *(University of Florida), Professor*
Analytical chemistry and separation science: capillary electrophoresis, electrochromatography, electrokinetic and liquid chromatography. Separation theory: chiral separations, physiochemical measurements. Novel separation media: micelles, mixed micelles, vesicles and liposomes. Retention mechanisms, stationary phase optimization, biomedical and pharmaceutical applications, peak shape

analysis.

James P. Friend, Ph.D. *(Columbia University), Professor Emeritus*
Atmospheric chemistry: atmospheric photochemistry, atmospheric transport of reacting species, global cycles of atmospheric trace constituents, formation of atmospheric nuclei, chemistry of atmospheric pollutants, atmospheric turbulent diffusion, modeling of atmospheric transport phenomena.

Robert O. Hutchins, Ph.D. *(Purdue University), G. S. Sasin Professor of Organic Chemistry*
Organic chemistry: conformational analysis and stereochemistry, new selective synthetic techniques including asymmetric synthesis, neighboring group participation in bicyclic systems, phosphorus chemistry.

Jack Garvin Kay, Ph.D. *(University of Kansas), Professor*
Inorganic and physical chemistry: spectroscopy of diatomic molecules, flash heating and kinetic spectroscopy, chemical effects of nuclear transformation, flash photolysis and radiation of solids, annealing and reactions of defects in crystals, solar furnaces, chemistry at surfaces, radon and radon daughters in the atmosphere.

Frederick R. Longo, Ph.D. *(University of Pennsylvania), Professor Emeritus*
Studies of the pi-delocalization pathway in porphyrins via chemical luminescence and electrochemical properties; structure of and reactions in micro-emulsions, including light-scattering, luminescence quenching, and catalytic hydrolysis of esters.

Amar Nath, Ph.D. *(Moscow State University, Russia), Professor*
Physical chemistry: isotopic exchange in the solid state, charge injection, electrons and holes, thermally stimulated luminescence, current and exoelectron emission; chemistry of vitamin B; co-operativity in hemoglobin; Mössbauer study of Auger events.

Kevin G. Owens, Ph.D. *(Indiana University), Associate Professor*
Analytical/physical chemistry: biological and synthetic polymer analysis using matrix-assisted laser desorption/ionization (MALD/I) time-of-flight mass spectrometry (TOFMS); development of sample preparation techniques for quantitative MALD/I analysis; gas-phase laser ionization TOFMS; supersonic jet spectroscopy; application of correlation analysis and chemometric techniques in mass spectrometry.

Carey M. Rosenthal, Ph.D. *(Harvard University), Associate Professor*
Chemical physics: application of space-filling curves and line integral representations to scattering problems.

Allan L. Smith, Ph.D. *(Massachusetts Institute of Technology), Professor*
Physical chemistry: thermodynamics of the solubility of fullerenes and their derivatives, heat-conduction microcalorimetry and its application to surface phenomena, high-temperature gas phase absorption spectroscopy of molecular sulfur species.

Karl Sohlberg, Ph.D., *(University of Delaware), Assistant Professor*
Theoretical/computational physical chemistry: applications of quantum mechanics to materials, kinetics and thermodynamics of hydrogen in catalytic materials, surfaces of heterogeneous catalysts, dynamics of electrical and mechanical molecular devices, fundamental theories of chemical reaction dynamics.

Sally D. Solomon, Ph.D. *(University of Pennsylvania), Professor*

Computer applications: artificial intelligence tutorial dialogues using natural language processing; highly interactive problem-solving modules. Classroom materials: laboratory experiments utilizing household chemicals; overhead projector lecture demonstrations for courses at all levels.

Peter A. Wade, Ph.D. *(Purdue University), Associate Professor*
Organic chemistry: new synthetic methods; synthetic, mechanistic, and stereochemical aspects of cycloaddition reactions; the chemistry of nitro compounds; natural product synthesis; new substitution reactions.

Yen Wei, Ph.D. *(City University of New York), Professor*
Polymer chemistry: synthesis of conducting polymeric materials and mechanisms of electrical conduction, stereochemical studies of polymerization reactions, chemistry in the solid state, biopolymers.

Facilities
Facilities include laboratories for research in analytical chemistry (three), inorganic chemistry, organic chemistry (three), physical chemistry (four), and polymer chemistry (two).

GC-Mass Spectrometer Laboratory
Finnigan 4500 GC-MS and data system, Finnigan 4510 GC-MS and data system, VG 7OSE mass spectrometer.

Instrumental Analytical Laboratory
Gas chromatographs (GCs), high-performance liquid chromatographs (HPLCs), Fourier-transform infrared spectrometer (IRs), atomic absorption spectrometers, UV-visible spectrophotometers, spectrophotofluorimeter, electro-analytical instrumentation.

Magnetic Resonance Laboratory
60-MHz and 90-MHz FT-NMR broad-band spectrometer, 250-MHz superconducting FT-NMR spectrometer, X-band EPR spectrometer.

Polymer Laboratory
Gel-permeation chromatograph, vapor pressure osmometer, thermogravimetric analyzer, differential scanning calorimeter.

Synthetic Organic Laboratories
Analytical and preparative HPLCs, GCs with capillary capabilities, radial chromatography, Fourier-transform IR, and a polarimeter.

Other Departmental Facilities
The department also maintains pulsed and CW lasers, circular dichroism, and FT-IR spectrometers. Computer facilities include a Sun Microsystems Sparc-5, two IBM RS6000 workstations, and a Silicon Graphics workstation, as well as a large number of desktop computers and a desktop molecular modeling facility (Hyperchem/ MOMEC, MacSpartan Plus). Full-time technical support includes glass, machine, and electronics shop personnel and a research instrumentation specialist.

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Communication

General Information

Drexel's Master of Science in communication prepares students for careers in a wide range of professional activities. The program specializes in three areas: technical communication, science communication, and public communication. Technical communication is for those seeking employment as technical writers, computer documentation specialists, and training specialists. Science communication has much to offer those who aspire to medical, science, and pharmaceutical writing. A concentration in public communication leads to careers in journalism and public relations. In addition, the program provides a strong foundation in theoretical approaches to communication. This theoretical basis is designed to ensure that, as the field changes, students will continue to have an intellectual framework for evaluating and implementing new technology and changing media.

Students can attend full time or part time, they can begin the program in any academic quarter, and they can complete all coursework in the evening. The program emphasizes flexibility, encouraging each student, in consultation with a faculty advisor, to fashion a particular course of study.

The program accommodates students from widely varying educational backgrounds: Many have backgrounds in science and mathematics; an equal number come from humanities-related areas. Some students pursue their degrees while already at work at demanding jobs in technical or scientific fields; others are new to the field. For students without previous work experience, the program requires a paid internship (described below).

Applicants to the program must meet the general requirements for admission to graduate studies as outlined earlier in this catalog. Prospective students must also submit with their applications a 1,500-word statement explaining why they want to enter the program. These statements are read carefully by the program's screening committee to evaluate each applicant's writing skills and sense of purpose.

Teaching and research assistantships are available to highly qualified applicants and will be awarded competitively according to merit.

Requirements

The M.S. degree requires 45 credits of coursework, a professional portfolio of three to five items developed by the student, and six months of paid internship for those who lack significant experience in technical or science communication.

Students who need professional experience consult with their advisors and the program director to develop a suitable internship. Normally, this placement begins after the student has completed at least half the required coursework. Students who already have the equivalent of six months of professional experience or who gain the equivalent by working part time during their course of study can request exemption from this requirement.

Curriculum

Students may use electives to increase communication skills, to broaden theoretical

backgrounds, or to develop areas of specialization. Any appropriate graduate course offered in the University can serve as an elective if the student has sufficient background to take the course. In addition, the program offers its own elective courses as special topics (COM 690). Qualified students may also pursue independent study for elective credit in special cases.

Core Courses

Courses		Credits
COM 500	**Reading and Research in Communication**	3.0
COM 610	**Theories of Communication and Persuasion**	3.0

Concentrations

Technical Communication

Courses		Credits
COM 510	**Technical Writing**	3.0
COM 570	**Technical and Science Editing**	3.0
COM 620	**Message Design and Evaluation**	3.0
COM 630	**Developing Software Documentation**	3.0
COM 875	**Seminar: Ethics in Technical and Science Communication**	3.0
	Core courses	6.0
	Electives	24.0

Science Communication

Courses		Credits
COM 520	**Science Writing**	3.0
COM 620	**Message Design and Evaluation**	3.0
COM 660	**Investigative Journalism**	3.0
COM 680	**Medical Writing**	3.0
	Core courses	6.0
	Electives	27.0

Public Communication

Courses		Credits
COM 635	**Writing for the World Wide Web**	3.0
COM 650	**Telecommunications Policy**	3.0
COM 660	**Investigative Journalism**	3.0
COM 670	**Public Relations**	3.0
	Core courses	6.0
	Electives	27.0

Faculty Research Interests

Ronald Bishop III, Ph.D. *(Temple University), Assistant Professor*
Journalism, public relations, mass media and body image.

Jacques M. Catudal, Ph.D. *(Temple University), Associate Professor*
Epistemology, philosophy of science, ethics.

Paula Marantz Cohen, Ph.D. *(Columbia University), Professor*
Theory and practice of public relations.

Alexander C. Friedlander, Ph.D. *(Carnegie Mellon University), Associate Professor*
Writing, rhetorical theory and practice, document design, cognitive processes.

Ernest A. Hakanen, Ph.D. *(Temple University), Associate Professor*
Telecommunications policy, adolescent media use, communication theory.

Mark Manion, Ph.D. *(Temple University), Assistant Professor*
Ethics, semantics.

Eva Thury, Ph.D. *(University of Pennsylvania), Associate Professor*
Computer programming and software design, classics, desktop publishing, software documentation.

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Mathematics and Computer Science

General Information

The Department of Mathematics and Computer Science is a broadly based academic unit offering instructional programs and carrying on research activities in mathematics, computer science, and statistics. Doctor of Philosophy and Master of Science degrees are offered.

Areas of research specialty among the faculty include applied mathematics, human-computer interaction, programming languages and compilers, software engineering, biostatistics, combinatorics, computer algebra, expert systems, functional analysis, number theory, numerical analysis, scientific computing, operations research, parallel processing, probability and statistics, special functions, supercomputing, symbolic computation, analysis of algorithms, artificial intelligence, and robotics.

Master of Science Program

The M.S. degree is available in mathematics and computer science. All programs are professionally oriented in the sense that they are primarily intended to prepare students for employment as practicing applied mathematicians, computational scientists, mathematical statisticians, computer specialists, or software engineers in business, industry, or government. Courses are designed to emphasize applications and computational methods as well as appropriate theoretical aspects. Requirements are sufficiently flexible to permit students to select coursework appropriate to their individual goals and interests.

An increasingly popular option for students with strong interest in both mathematics and computer science is the dual Master of Science in Mathematics and Computer Science. The dual degree provides students with the analytical skills of advanced mathematical study, combined with a full exposure to the most important topics in the dynamic field of computer science.

Many students pursue a dual M.S., combining their degree with a field outside the department; popular combinations are mathematics/physics, computer science/computer engineering, computer science/biomedical engineering, and computer science/software engineering. Drexel graduate students in degree programs other than mathematics and computer science must obtain departmental permission for the dual M.S.; see the department for details.

A degree program of related interest is the Master of Science in Software Engineering. This University program, jointly administered by the College of Information Science and Technology, the Department of Electrical and Computer Engineering, and the Department of Mathematics and Computer Science, includes a computer science option.

Doctoral Program

The Doctor of Philosophy degree is conferred in recognition of breadth of scientific attainment, plus demonstrated ability to investigate scientific problems independently and efficiently. At least three years of full-time study beyond the bachelor's degree are normally required (the master's degree is not a prerequisite).

The minimum requirements for a Ph.D. degree are successful completion of candidacy examinations, a dissertation showing original research of sufficient quality to be published in refereed journals appropriate for the degree emphasis, and an oral dissertation defense. Further details about the doctoral program may be obtained by contacting the Department of Mathematics and Computer Science.

Admissions Requirements

Applicants should hold a B.S. degree in mathematics, computer science, or some related technical area, and meet the regular admission standards for graduate studies at Drexel University. The Graduate Record Examination (GRE) is required of those students requesting financial assistance from the department. All international students requesting teaching or research graduate assistantships must take the TSE (Test of Spoken English) exam.

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. See the department for details.

Part-Time Students

Qualified people working in the Philadelphia area may enroll as part-time students. Graduate courses (including the core subjects) are offered in the late afternoon and evening hours to enable part-time students to complete the M.S. degree within a reasonable period of time.

General Requirements

Both mathematics and computer science students must complete a minimum of 45 graduate credits for the M.S. degree. Of these, at least 36 credits must be from 500-, 600-, and 700-level courses, including a core of 27 credits for mathematics and 36 for computer science. Core requirements are specified below. Elective courses taken outside the department must receive prior departmental approval in order to be counted toward the degree. Students seeking a dual M.S. must satisfy core requirements for both degree programs. Students seeking a dual M.S. in mathematics and computer science should check with the department for full details of the dual-degree requirements.

During the first term of study, matriculated students are assigned an advisor to assist them in preparing a complete plan of study. The plan of study serves as the sole document for determining graduation requirements.

Students should note that some departmental courses (e.g., Advanced Engineering Mathematics, Foundations of Computer Science, and UNIX Programming Environment) are foundation courses and do not contribute to the departmental requirements for the degree. They do count toward the University requirements for a degree.

Mathematics Core Requirements

In addition to the general requirements, a basic requirement for the M.S. in mathematics is the completion of a three-term sequence that involves linear algebra and/or analysis. Placement in these courses is determined before the beginning of the fall term, when a faculty advisor will help the student develop a complete plan of study. Specific requirements for areas of emphasis in mathematics are provided below.

Applied Mathematics

Courses		Credits
MATH 507	**Applied Mathematics I**	3.0
MATH 680	**Analysis I**	3.0
MATH 680	**Analysis II**	3.0
	Series electives	18.0

Statistics and Operations Research

Courses		Credits
MATH 510	**Applied Probability and Statistics I**	3.0
MATH 511	**Applied Probability and Statistics II**	3.0
MATH 512	**Applied Probability and Statistics III**	3.0

Two courses each from two of the following groups		12.0
MATH 523	**Computer Simulation I**	
MATH 524	**Computer Simulation II**	
MATH 525	**Topics in Computer Simulation**	
MATH 610	**Advanced Probability and Statistics I**	
MATH 611	**Advanced Probability and Statistics II**	
MATH 612	**Topics in Advanced Probability and Statistics**	
MATH 613	**Stochastic Processes I**	
MATH 614	**Stochastic Processes II**	
MATH 615	**Topics in Stochastic Processes**	
MATH 670	**Methods of Optimization I**	
MATH 671	**Methods of Optimization II**	
MATH 672	**Topics in Methods of Optimization**	

	Series electives	6.0

Scientific Computation

Courses		Credits
CS 557	**Data Structures and Algorithms I**	3.0
CS 680	**Special Topics: Applied Computer Algebra**	3.0
CS 680	**Special Topics: Computer Algebra I**	3.0
CS 680	**Special Topics: Computer Algebra II**	3.0
MATH 520	**Numerical Analysis I**	3.0
MATH 521	**Numerical Analysis II**	3.0
MATH 522	**Numerical Analysis III**	3.0
	Series electives	6.0

Computer Science Core Requirements

In addition to the general requirements, the core requirements for the M.S. in computer science are as follows:

Computer Science

Courses		Credits
CS 557	**Data Structures and Algorithms I**	3.0
CS 558	**Data Structures and Algorithms II**	3.0
CS 559	**Theory of Computation**	3.0

CS 560	**Programming Languages**	3.0
CS 720	**Operating Systems**	3.0
CS 740	**Computer Networking**	3.0
	All students must take three intermediate-level courses and one advanced course. Check with Department of Mathematics and Computer Science for course listing.	12.0
	Students may select a thesis option for six credits. Students who do not select the thesis option must take two additional courses from either the intermediate or the advanced level.	6.0

Faculty Research Interests

Loren N. Argabright, Ph.D. *(University of Washington), Professor Emeritus*
Functional analysis, wavelets, abstract harmonic analysis, the theory of group representations.

Robert P. Boyer, Ph.D. *(University of Pennsylvania), Professor and Associate Department Head*
Functional analysis, C*-algebras and the theory of group representations.

Robert C. Busby, Ph.D. *(University of Pennsylvania), Professor*
Functional analysis, C*-algebras and group representations, generalized harmonic analysis and wavelets, integration of computer science and software into undergraduate mathematics.

Bruce W. Char, Ph.D. *(University of California at Berkeley), Professor*
Symbolic mathematical computation, algorithms and systems for computer algebra, problem-solving environments, parallel and distributed computation.

Ewaugh Finney Fields, Ed.D. *(Temple University), Professor and Dean Emeritus*
Mathematics education, curriculum and instruction, minority engineering education.

William M. Y. Goh, Ph.D. *(Ohio State University), Associate Professor*
Number theory, approximation theory and special functions, combinatorics, asymptotic analysis.

Herman Gollwitzer, Ph.D. *(University of Minnesota), Associate Professor*
Applied mathematics, differential equations, data analysis, user interface design, visualization, scientific computing.

Lloyd Greenwald, Ph.D. *(Brown University), Assistant Professor*
Planning, robotics, real-time scheduling, resource-bounded reasoning, anytime algorithms, sequential decision-making, time-critical deliberation.

Nira Herrmann, Ph.D. *(Stanford University), Professor and Department Head*
Mathematical and applied statistics; early decision problems, expert systems in statistics, computer science; multivariate analysis, biostatistics.

Thomas Hewett, Ph.D. *(University of Illinois), Professor*
Human-computer interaction, cognitive psychology, computer applications.

R. Andrew Hicks, Ph.D. *(University of Pennsylvania), Assistant Professor*
Computer vision and robotics, catadioptics.

Pawel Hitczenko, Ph.D. *(Warsaw University), Associate Professor*
Probability, combinatorics, wavelets.

Jeremy R. Johnson, Ph.D. *(Ohio State University), Associate Professor*
Computer algebra, algebraic algorithms, DSP algorithms, high-performance computing, programming languages.

Bernard Kolman, Ph.D. *(University of Pennsylvania), Professor Emeritus*
Lie algebras; theory, applications, and computational techniques; operations research.

Werner Krandick, Ph.D. *(Ohio State University), Assistant Professor*
Computer algebra, parallel computation, computer arithmetic.

Spiros Mancoridis, Ph.D. *(University of Toronto), Associate Professor*
Software engineering, software architecture, reverse engineering, software testing, software visualization, software engineering education.

Charles J. Mode, Ph.D. *(University of California at Davis), Professor Emeritus*
Probability and statistics, biostatistics, epidemiology, mathematical demography, data analysis, computer-intensive methods.

Oksana Mokliatchouk, Ph.D. *(Columbia University), Assistant Professor*
Survival analysis, genetics (link age analysis), pre-Gaussian and square-Gaussian random vectors and processes.

Ronald K. Perline, Ph.D. *(University of California at Berkeley), Associate Professor*
Applied mathematics, numerical analysis, symbolic computation, differential geometry, mathematical physics.

Marci A. Perlstadt, Ph.D. *(University of California at Berkeley), Associate Professor*
Applied mathematics, computed tomography, numerical analysis of function reconstruction, signal processing, combinatorics.

Jeffrey L. Popyack, Ph.D. *(University of Virginia), Associate Professor*
Operations research; stochastic optimization, computational methods for Markov decision processes; artificial intelligence; computer science education.

Vassilie Prevelakis, Ph.D. *(University of Geneva), Assistant Professor*
Computer networking, network security, operating systems, software engineering.

William Regli, Ph.D. *(University of Maryland), Associate Professor*
Artificial intelligence, computer-aided design, information-based manufacturing, Internet computing.

Chris Rorres, Ph.D. *(Courant Institute, New York University), Professor Emeritus*
Applied mathematics, scattering theory, mathematical modeling in biological sciences, solar collection systems.

Dario Salvucci, Ph.D. *(Carnegie Mellon University), Assistant Professor*
Human-computer interaction, cognitive systems, interactive systems, machine learning.

Eric Schmutz, Ph.D. *(University of Pennsylvania), Associate Professor*

Discrete mathematics and combinatorial probability, probabilistic methods in combinatorics, number theory, graph theory and computer science.

Li Sheng, Ph.D. *(Rutgers University), Assistant Professor*
Discrete optimization, probabilistic methods in combinatorics, operations research, graph theory and its application in molecular biology, social sciences and communications networks, biostatistics, computer science.

Ali Shokoufandeh, Ph.D. *(Rutgers University), Assistant Professor*
Theory of algorithms, theoretical computer science, graph theory, combinatorial optimization, combinatorial methods in computer vision and robotics.

Justin Smith, Ph.D. *(Courant Institute, New York University), Professor*
Computer science, parallel algorithms, artificial intelligence, computer vision.

Vasily V. Strela, Ph.D. *(Massachusetts Institute of Technology), Assistant Professor*
Wavelet theory and multiresolution analysis; implementation of wavelets and filter banks in signal processing, numerical analysis, and statistics; Toeplitz and circulant matrices.

Chunguang Sun, Ph.D. *(Penn State University), Assistant ProfessorGeneral Department Facilities*

Departmental and University networks provide access to the Internet and the Pennsylvania Education Network (PrepNET). Departmental research computers have a connection to the campus backbone at 100 Mbps and are also on the vBNS via a campus OCS ATM connection.

Facilities include two UNIX file servers and two UNIX compute servers. There are 14 Sun workstations for student use and several UNIX workstations for research (including some dual-processor models). There are 20 PCs (Windows NT) and several Macs for student use. Research machines include several NT workstations and servers, and faculty/staff have various Macs and PCs, some running Linux.

Application-Specific Computing Laboratory (joint lab with ECE)

The lab has three dual-processor Pentium III servers and several Pentium III, Pentium IV, and AMD Athlon Windows/

Linux workstations. The lab also has two FPGA (Xilinx Virtex 2) boards from Annapolis Micro Systems and a TI-TMS320C6701 DSP processor.

Intelligent Time-Critical Systems Laboratory (affiliated with Drexel Robotics)

The lab is equipped with a Sun Ultra 60 dual-processor capable server, three Linux workstation/servers, one Windows NT/Linux dual-boot workstation, and one dedicated Linux workstation. Mobile robotics hardware includes 12 Logo robot development kits with Handyboards, and a Nomadics Super Scout II robot base with color vision, sonar, and tactile sensors; onboard processing; Ethernet; radio communications; and a full-featured mobile robot development system. The lab includes dedicated, flexible space for experimental research with table-top, small-scale, and large-scale robot bases.

Problem-Solving Environment Laboratory

The PSE lab equipment includes two multiprocessor Sparc Ultra 2s, one Windows NT workstation, and one Windows NT server.

Software Engineering Laboratory

This lab has four Pentium II Windows NT workstations, a Pentium Windows NT workstation, a Pentium II Linux workstation, and an Ultra Sparc Solaris Workstation.

Laboratory for Geometric and Intelligent Computation

This lab includes a heterogeneous network of Sun Solaris-based and Intel/Windows NT-based workstations and Silicon Graphics Visual Workstation 320s with advanced CAD/CAE, graphics, and visualization capabilities (single- and dual-processor 300 MHz P-IIs, four 450 MHz P-IIs) and UNIX (Solaris Sparc, Solaris x86, Linux, IRIX) graphics workstations and servers (including Sun Ultra 30, Ultra 2, Ultra Sparc 10, and Sparc Server 5, 266 MHz P-II, AMD K6-200, and SGI Power Series servers); Cylink Virtual LAN encryption hardware; and a Bridgeport VMC 600 Vertical Machining Center. The lab has the latest CAD/CAM/CAE database/product data management and development software systems: SDRC I-DEAS Master Series V6 (NT and Solaris), Bentley Microstation Modeller, EZ-CAM, Oracle Server and SDRC Metaphase/EVista (PDM) (NT and Solaris), GeoPlex Electronic Commerce System (AT&T), Adams (mechanism analysis), Cosmos (FEA), Sun Java workstation, and Microsoft Visual Studio Suite. GICL's disk farm includes more than 250 gigabytes of storage.

Parallel processing, scientific computation, numerical linear algebra, combinatorial and numerical optimization.

Jet Wimp, Ph.D. *(University of Edinburgh), Professor Emeritus*
Applied mathematics, special functions, approximation theory, numerical techniques, asymptotic analysis.

Facilities
General Department Facilities

Departmental and University networks provide access to the Internet and the Pennsylvania Education Network (PrepNET). Departmental research computers have a connection to the campus backbone at 100 Mbps and are also on the vBNS via a campus OCS ATM connection.

Facilities include two UNIX file servers and two UNIX compute servers. There are 14 Sun workstations for student use and several UNIX workstations for research (including some dual-processor models). There are 20 PCs (Windows NT) and several Macs for student use. Research machines include several NT workstations and servers, and faculty/staff have various Macs and PCs, some running Linux.

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Master of Science Programs

Master of Science in Environmental Engineering
Master of Science in Environmental Science
Master of Science in Environmental Policy

The degrees offered in this program are the Master of Science in Environmental Engineering, the Master of Science in Environmental Science, and the Master of Science in Environmental Policy. The requirements for the M.S.E.E., M.S.E.S., and M.S.E.P. degrees include two sets of courses. The first three or four are required core courses that form the basis for further specialization. The second seven to nine courses make up the area of specialization.

Master's thesis students may choose either a thesis or a nonthesis option. All master's students who are awarded assistantships or who are receiving other forms of financial assistance from the University must complete a thesis. This requirement does not apply to those receiving aid only from sources outside the University.

Students choosing the thesis option complete 6 to 9 credits for the thesis and related research and choose up to 9 credits of related electives, for a total of 45 credits. Those who select the nonthesis option complete a total of 48 credits of coursework.

Full-time students may complete the M.S. degree in five or six terms (15 to 18 months). Part-time students require three to five years, depending on the number of courses taken per term.

All degree candidates must have a plan of study. Before preparing this plan students should consult with the advisor assigned to them by the program director.

The core courses should be taken first, as foundation courses for those to follow (they are prerequisites for some specialized courses).

Curriculum

Core courses		Credits
ENVR 501	**Chemistry of the Environment**	3.0
ENVR 506	**Biostatistics**	3.0
ENVR 511	**Evolutionary Ecology***	
and/or		
ENVR 521	**Environmental Health****	3.0

***Required for all students except those specializing in environmental health or environmental risk management.**

****Required for environmental policy students and students specializing in environmental health or environmental risk management.**

Areas of Specialization

All programs of study include one of the following curricula, unless a special program has been approved by an academic advisor and the School's graduate advisor. The first six curricula listed are available for both environmental engineering and

environmental science candidates. The next five curricula are for environmental science candidates only. The last curriculum listed is for environmental policy candidates.

Environmental Engineering/Environmental Science Specializations

Air pollution		Credits
ENVR 541	**Air Pollution Meteorology**	3.0
ENVR 560	**Fundamentals of Air Pollution Control**	3.0
ENVR 605	**Atmospheric Chemistry**	3.0
ENVR 641	**Community Air Pollution**	3.0
ENVE 642	**Control of Gas/Vapor Pollutants from Industrial and Mobile Sources**	3.0
ENVR 644	**Design of Particulate Control Devicesand Systems**	3.0
ENVR 742	**Atmospheric Aerosols**	3.0
ENVR 865	**Special Topics: Air Pollution Modeling**	3.0

Environmental risk management		Credits
COM 610	**Theories of Communication and Persuasion**	3.0
EGMT 531	**Economics for Engineering**	3.0
ENVE 727	**Risk Assessment**	3.0
ENVR 522	**Environmental Law**	3.0
ENVR 523	**Environmental Regulations**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 621	**Epidemiology**	3.0
ENVR 636	**Toxicology and Human Physiology**	3.0

Hazardous and solid wastes		Credits
ENVE 660	**Chemical Kinetics, Mass Transfer, and Reactor Design in Environmental Engineering**	3.0
ENVE 661	**Environmental Engineering Unit Operations — Chemical and Physical**	3.0
ENVE 665	**Hazardous Waste and Groundwater Treatment**	3.0
ENVE 727	**Risk Assessment**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 636	**Toxicology and Human Physiology**	3.0
ENVR 741	**Toxic and Hazardous Air Pollutants**	3.0
ENVR 865	**Special Topics: Biological Hazardous Waste Treatment; Leachate and Landfill Design**	9.0

Subsurface contaminant hydrology		Credits
CHE 502	**Mathematical Methods in Chemical Engineering**	3.0
CIVE 790	**Special Topics: Introduction to Geology**	3.0
EGEO 710	**Introduction to Geophysics**	3.0
ENVE 681	**Groundwater Hydrology**	3.0
ENVE 682	**Subsurface Contaminant Transport**	3.0
ENVE 683	**Stochastic Subsurface Hydrology**	3.0
ENVR 516	**Sanitary Microbiology**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 616	**Environmental Microbiology**	3.0

Water and wastewater treatment		Credits
ENVE 602	**Water Quality Control Laboratory**	3.0
ENVE 660	**Chemical Kinetics, Mass Transfer, and Reactor Design in Environmental Engineering**	3.0
ENVE 662	**Environmental Engineering Unit Operations — Biological**	3.0
ENVE 661	**Environmental Engineering Unit Operations — Chemical and Physical**	3.0
ENVR 516	**Sanitary Microbiology**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 611	**Aquatic Ecology**	3.0
ENVR 711	**Aquatic Toxicology**	3.0
ENVR 751	**Stream Analysis and Pollution Control**	3.0

Water resources		Credits
CIVE 660	**Hydrology: Stream Flow**	3.0
ENVE 681	**Groundwater Hydrology**	3.0
ENVE 684	**Water Resources Systems Analysis**	3.0
ENVR 561	**Introduction to Hydrology**	3.0
ENVR 602	**Water Quality Control Lab**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 611	**Aquatic Ecology**	3.0

Environmental Science Specializations

Ecology		Credits
ENVR 611	**Aquatic Ecology**	3.0
ENVR 670	**Microbial Ecology**	3.0
ENVR 690	**Marine Ecology**	3.0
ENVR 710	**Physiological Ecology**	3.0
ENVR 712	**Biophysical Ecology**	3.0
ENVR 722	**Tropical Ecology**	3.0
ENVR 865	**Special Topics: Biodiversity and Conservation**	3.0

Environmental assessment		Credits
ENVE 726	**Environmental Assessment**	3.0
ENVE 727	**Risk Assessment**	3.0
ENVR 516	**Sanitary Microbiology**	3.0
ENVR 541	**Air Pollution Meteorology**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 611	**Aquatic Ecology**	3.0
ENVR 616	**Environmental Microbiology**	3.0
ENVR 711	**Aquatic Toxicology**	3.0

Environmental biotechnology		Credits
BIO 500	**Biochemistry I**	3.0
BIO 501	**Biochemistry I Laboratory**	2.0
BIO 530	**Techniques in Microbial Genetics**	5.0
BIO 610	**Biochemistry II**	3.0
ENVE 726	**Environmental Assessment**	3.0
ENVR 516	**Sanitary Microbiology**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 616	**Environmental Microbiology**	3.0
ENVR 757	**Bioremediation**	3.0

Environmental chemistry		Credits
ENVE 602	**Water Quality Control Laboratory**	3.0

ENVE 660	**Chemical Kinetics, Mass Transfer, and Reactor Design in Environmental Engineering**	3.0
ENVE 661	**Environmental Engineering Unit Operations — Chemical and Physical**	3.0
ENVE 702	**Advanced Environmental Instrumentation**	3.0
ENVR 601	**Advanced Environmental Chemistry**	3.0
ENVR 605	**Atmospheric Chemistry**	3.0
ENVR 608	**Fate of Pollutants in Air and Water**	3.0
ENVR 611	**Aquatic Ecology**	3.0

Environmental health		**Credits**
ENVE 534	**Industrial Ventilation**	3.0
ENVE 535	**Industrial Safety**	3.0
ENVE 727	**Risk Assessment**	3.0
ENVR 522	**Environmental Law**	3.0
ENVR 531	**Industrial Hygiene I**	3.0
ENVR 532	**Industrial Hygiene II**	3.0
ENVR 533	**Industrial Hygiene Laboratory**	3.0
ENVR 621	**Epidemiology**	3.0
ENVR 636	**Toxicology and Human Physiology**	3.0
ENVR 736	**Toxicology**	3.0

Environmental Policy Program

Courses		**Credits**
ECON/ ENVR 865	**Resource and Environmental Economics**	3.0
ENVR 522	**Environmental Law**	3.0
ENVR 523	**Environmental Regulations**	3.0
ENVR 710	**Environmental Cost-Benefit Analysis and Valuation**	3.0
ENVR 760	**Social Change and Environmental Movements**	3.0
ENVR 771	**Theory and Practice of Environmental Policy Analysis**	3.0
ENVR 772	**Methods of Environmental Policy Analysis**	3.0
ENVR 773	**Practicum in Environmental Policy Analysis**	3.0
ENVR 774	**Economics Analysis of Environmental Policy**	3.0

Recommended electives		
ENVE 727	**Risk Assessment**	3.0
ENVR 880	**Environment and Society**	3.0
ENVR 885	**International Environmental Politics**	3.0
ENVR 886	**Methods of Resource and Economic Evaluation**	3.0

Special Programs

In collaboration with various departments, students may design special programs in other areas, such as urban planning or environmental geology.

Specialty courses and electives offered by allied departments		Credits
CHE 502	**Mathematical Methods in Chemical Engineering**	3.0
CHEM 551	**Radiochemistry**	3.0
CIVE 660	**Hydrology: Stream Flow**	3.0
CIVE 662	**Hydrodynamics I**	3.0
CIVE 663	**Hydrodynamics II**	3.0
CIVE 664	**Open Channel Hydraulics**	3.0
CIVE 790	**Special Topics: Free Surface Flows**	3.0
CIVE 790	**Special Topics: Computational Hydraulics**	3.0
ECON 616	**Public Finance and Cost-Benefit Analysis**	3.0
EGEO 630	**Engineering Geology**	3.0
FIN 628	**Capital Budgeting**	3.0
OPR 620	**Operations Research I**	3.0
OPR 622	**Operations Research II**	3.0
OPR 624	**Advanced Mathematical Programming**	3.0
OPR 626	**System Simulation**	3.0
PHEV 541	**Atmospheric Physics I**	3.0
PHEV 544	**Large-Scale Atmospheric Dynamics**	3.0
PHEV 547	**Small-Scale Atmospheric Dynamics**	3.0
STAT 622	**Statistical Decision Theory I**	3.0
STAT 626	**Statistical Sampling**	3.0
STAT 636	**Experimental Design**	3.0

Thesis and/or Electives
Students complete the program by earning credits for a thesis, electives, or a combination of thesis research and electives. A maximum of 9 credits of research and/or thesis can be applied to the M.S. degree (thesis option).

Nutrition and Food Science

General Information

The graduate programs in nutrition and food science provide a biochemically based professional education, encompassing both classroom theory and practical research and application. The master's program offers two majors: human nutrition and food science.

The human nutrition major is concerned with normal and therapeutic nutrition for individuals and groups. This major also encompasses nutrition science, the application of the principles of biochemistry, physiology, and biology to human nutritional needs. Students who wish to pursue a clinical nutrition emphasis follow a modified version of the basic human nutrition curriculum. Current research in human nutrition includes food preference and nutrition, nutrition assessment, effectiveness of nutrition education (particularly by the use of multimedia) on health and eating habits, and dietetic professional development. Current research in nutrition science includes physiological and genetic determinants of obesity, lipid metabolism, neutraceuticals, and diet-endocrine interrelationships.

Food science is concerned with foods and food ingredients, and their physicochemical and biochemical interactions at the molecular, functional, and cellular levels. The food science major applies the principles of chemistry, biochemistry, microbiology, physics, and engineering to the production, safety, and quality of the food supply. Current research in food science includes physicochemical changes during deep-fat frying, lipid oxidation in foods, organoleptic evaluation of foods, food safety, and the effect of food processing on nutrients.

All specializations stress the interdisciplinary and scientific nature of nutrition and food and provide students with a base of theoretical knowledge and methodology enabling them to continue professional growth after graduation. Students strengthen professional status through in-depth study of current scientific concepts, engage in evaluation of new information, and develop and demonstrate a spirit of intellectual inquiry and constructive criticism. Students participate in the research enterprise by completing a research project or by designing and executing a thesis under faculty direction.

The program cooperates with nearby universities and research and medical institutions, enabling students to take courses at other institutions and to be involved in joint research projects. Information on these opportunities is available from faculty in the department.

Graduate study in nutrition and food science is offered on both a full-time and part-time basis.

Financial Assistance

A limited number of teaching assistantships are available for students in the thesis option; contact the department head for more information. A limited number of research assistantships are available depending on funded research of individual faculty; contact faculty members for more information. Assistantships normally provide for waiver of tuition and a modest stipend. The University Financial Aid

Office can provide information about the availability of work-study funds and higher education assistance loans.

Undergraduate Prerequisites

The program's approach to graduate study in nutrition and foods is quantitative; therefore, applicants should have demonstrated competency in the coursework or its equivalent listed in the following table.

A review of the applicant's transcript determines in what order any necessary undergraduate coursework shall parallel or precede graduate study. All newly accepted students are urged to systematically review their previous academic work, particularly in the areas of mathematics and biochemistry, prior to enrolling in their first graduate courses in the program. NFS 500 (Nutritional and Metabolic Chemistry), or an equivalent course in biochemistry, is a prerequisite for all other program courses. If not taken previously, the course must be taken the summer before the first fall term as a graduate student.

- **General chemistry** (inorganic and organic) 1 year
- **Biochemistry** 1 or 2 terms or semesters
- **General biology** 1 or 2 courses
- **Human physiology** 1 or 2 courses
- **Microbiology** 1 course
- **Mathematics** 2 courses including derivatives and integrals
- **Statistics** 1 course
- **General psychology** 1 course
- **Foods** 2 terms or 1 semester
- **Nutrition** 1 course

Additional prerequisites for the food science major are:

- **Physics** 2 terms or semesters
- **Calculus** 2 terms or semesters
- **Organic chemistry** 2 terms or semesters

Additional prerequisites for the human nutrition major are:

- **Nutrition in the life cycle** 1 course
- **Advanced nutrition** 2 terms or 1 semester
- **Therapeutic nutrition** 2 terms or 1 semester*

**Required for the clinical emphasis.*

Master of Science Program

Forty-five credits are required for the M.S. degree. Soon after matriculation students consult with their advisors and complete a plan of study. All students are expected to file a plan of study with the graduate advisor before the end of their third term of matriculation. In addition to the core curriculum described below, students select specialty courses relating to their major, as well as electives.

All graduate students are expected to attend BIO 865 seminar presentations even if not registered for the course, unless specifically excused by the department head or graduate advisor. All thesis students should attend BIO 870 seminars.

Research

Students are invited to participate in research by systematically designing and completing a research project or thesis. All thesis students consult with a faculty

advisor and prepare a research proposal. Students present their proposals to their thesis committee for approval and, at the prerogative of the faculty, complete the research and report on it in seminar presentations. Students may elect to work in ongoing research or in some cases may suggest a new research area of specific interest to them. Individual guidance is necessary before research can commence, and there is periodic review during the course of the work. Students must submit a final written thesis to their thesis committee and defend the thesis at a final oral examination. Students in the thesis option may include up to six credits of NFS 997, Research in Nutrition and Food Sciences, among their electives.

Students selecting the nonthesis option are required to pass a written comprehensive examination. Students in the nonthesis option may include up to three credits of NFS 997, Research in Nutrition and Food Sciences, among their electives.

Core Curriculum

All graduate students must satisfy the following core course requirements.

Courses		Credits
BIO 610	**Biochemistry II**	3.0
BIO 641	**Data Analysis in the Biosciences**	3.0
BIO 865	**Seminar in Bioscience (may be taken twice)**	1.0
BIO 870	**Graduate Research Seminar**	1.0
NFS 531	**Micronutrient Metabolism**	3.0
NFS 601	**Research Methods in Applied Nutrition**	3.0

Food Science Major

The food science major is concerned with foods and food ingredients, and their physicochemical and biochemical interactions at the molecular and cellular levels. The food science major applies the principles of chemistry, microbiology, physics, and engineering to the production, safety, and quality of the food supply.

Courses		Credits
BIO 510	**Biochemistry I**	3.0
NFS 554	**Microbiology and Chemistry of Food Safety**	3.0
NFS 558	**Nutritional Impact of Food-Processing Methods**	3.0
NFS 560	**Advanced Food Chemistry**	3.0
NFS 561	**Advanced Food and Nutrient Analysis**	3.0
NFS 562	**Taste and Odor: Organoleptic Testing Methodology**	3.0
NFS 650	**Food Microbiology**	3.0
NFS 669	**Readings in Food Science**	3.0
	Core courses	14.0
	Electives*	10.0

***Electives are selected from departmental or related course offerings (excluding NFS 500, NFS 506, and NFS 508) in consultation with the student's graduate advisor. Possibilities include courses in various aspects of nutrition; special topics in food science such as lipids, proteins, carbohydrates, or packaging; microbial physiology; microbial genetics; recombinant DNA techniques; biophysical chemistry; analytical chemistry; biochemistry; bioengineering and process systems; epidemiology; and environmental sciences. Students electing the thesis option may include up to six credits of NFS 997 (Research in Nutrition and Food Sciences) among their electives.**

Human Nutrition Major

The human nutrition major applies the principles of normal, preventive, and therapeutic nutrition to nutrition education and clinical practice. Students may select courses to focus on preventive community nutrition, therapeutic clinical nutrition, or human nutrition science. Several courses are designed to provide specialized training for advanced practice in dietetics.

Courses		Credits
One of the following		**3.0**
NFS 554	**Microbiology and Chemistry of Food Safety**	
NFS 558	**Nutritional Impact of Food-Processing Methods**	
Two of the following		**6.0**
NFS 629	**Readings in Nutrition Science***	
NFS 649	**Readings in Nutrition***	
NFS 735	**Case Studies in Clinical Nutrition*†**	
NFS 849	**Readings in Therapeutic Nutrition*†**	
Four of the following human nutrition electives		**12.0**
NFS 530	**Macronutrient Metabolism**	
NFS 630	**Nutrition Counseling†**	
NFS 634	**Women's Issues in Nutrition**	
NFS 640	**Nutrition of the Schoolchild**	
NFS 641	**Nutrition in Later Maturity**	
NFS 680	**Drug-Nutrient Interactions**	
NFS 680	**Sports Nutrition**	
NFS 680	**Metabolic Nutrition Support†**	
NFS 690	**Community Nutrition**	
NFS 696	**Methods of Teaching Dietetics**	
NFS 730	**Nutritional Assessment**	
NFS 732	**Weight Management and Eating Disorders**	
	Core courses	14.0
	Free electives**	7.0

***Prerequisite: at least 30 graduate credits, including 6 credits of human nutrition electives.**

****Any graduate course in the department or university for which the student has the prerequisites (excluding NFS 500, NFS 506, and NFS 508).**

† Prerequisites for clinical emphasis courses include NFS 443 and NFS 444, Therapeutic Nutrition I and II.

Doctoral Program

Nutrition and Food Science is a part of the Department of Bioscience and

Biotechnology, and the Doctor of Philosophy requirements are those of the department. Applicants without an M.S. degree should initially apply for admission as M.S. degree candidates. The Ph.D. degree requires a minimum of 90 credits beyond the bachelor's degree. Depending on the applicant's background, a qualifying examination may be required. Candidates must demonstrate appropriate scientific scholarship and the ability to conduct independent research representing a significant contribution to their chosen field. Ph.D. students must pass a candidacy examination and an oral defense of their dissertations. Applicants interested in the Ph.D. program should contact potential major professors for an appointment to discuss research interests.

Faculty Research Interests

A. Philip Handel, Ph.D. *(University of Massachusetts), Associate Professor*
Food science, especially lipid chemistry; food composition and functionality; evaluation and analysis of frying fats and fried foods.

Shortie McKinney, Ph.D. *(Ohio State University), Registered Dietitian, Professor*
Clinical nutrition, infant nutrition, health and behavior, food preferences and attitudes, dietary counseling and compliance, computerized diet analysis, computerized health education.

Donna H. Mueller, Ph.D. *(Temple University), Registered Dietitian, Associate Professor*
Clinical nutrition; pediatric nutrition; nutrition in pulmonary diseases, especially cystic fibrosis; nutrition in developmental delay; dental nutrition; dietetic education and professional development.

Stanley Segall, Ph.D. *(Massachusetts Institute of Technology), Professor*
Flavor evaluation in foods, human organoleptic response, taste and odor, chemistry of sugars in foods, irradiation effects in foods, food science, food safety.

Orien L. Tulp, Ph.D. *(University of Vermont), Professor*
Diet and thermogenesis, adipose cellularity, obesity and metabolism, diet and brown adipose tissue, diabetes and diet, neutraceuticals, and diet-endocrine interrelationships.

Facilities

Instruments include a Hewlett-Packard 5890A gas-liquid chromatograph with integrator, a Perkin-Elmer high-performance liquid chromatograph, a Kruss K10 tensiometer for surface and interfacial tension, a gamma isotope counter, a beta isotope counter, an atomic absorption spectrophotometer, a UV-vis spectrophotometer, a YSI industrial analyzer for saccharide analysis, a particle/cell counter, an indirect calorimeter, and food preparation and sensory evaluation facilities.

The Nutrition Center provides a facility for human nutrition assessment and nutrition counseling. The center has two private counseling rooms equipped with video cameras, a small kitchen for client education activities, a private anthropometric assessment facility, and video education resources, and is equipped to provide appropriate nutrition education materials for clients.

Physics

General Information

The Department of Physics awards master's and doctoral degrees in physics and in a variety of interdisciplinary fields such as astrophysics and biological physics.

Applicants need to have a bachelor's degree in physics or in a related field, with a strong background in classical and modern physics and in mathematics.

Both full- and part-time study are available. Students may also enroll under the co-operative education plan, which offers alternating periods of study and employment.

The department offers a certain number of teaching and research assistantships to help support graduate students.

Master of Science Program

The requirement for the master's degree in physics is 45 graduate credits, with at least 30 credits taken in dynamics, mathematical physics, electricity and magnetism, quantum mechanics, and statistical mechanics. There are no thesis, language, or special examination requirements for the master's degree. Degrees are also available in collaboration with other departments and programs.

Doctoral Program

The Doctor of Philosophy degree is conferred in recognition of breadth of scholarship and scientific attainment, plus demonstrated ability to investigate scientific problems independently and efficiently. Doctoral students are required to take a minimum of 45 credits of coursework and research work beyond the master's requirement of 45 credits. The successful Ph.D. candidate must pass a candidacy examination, written and oral; satisfy a one-year residence requirement; and perform original research, write a satisfactory thesis describing that research, and defend the thesis in an oral examination. Involvement in the teaching activities of the Physics and Atmospheric Science Department is required of all Ph.D. applicants.

Faculty Research Interests

S. M. Bose, Ph.D. *(University of Maryland), Professor*
Theory of surfaces and interfaces, disordered systems, electron and X-ray spectroscopy of solids, high-temperature superconductivity.

Joan Centrella, Ph.D. *(Cambridge University), Professor*
General relativity and cosmology, large-scale computations of astrophysical gravitational wave sources. On leave.

Leonard D. Cohen, Ph.D. *(University of Pennsylvania), Professor Emeritus*

N. John DiNardo, Ph.D. *(University of Pennsylvania), Professor*
Surface physics using various probes including STM, AFM, and synchrotron radiation.

Frank A. Ferrone, Ph.D. *(Princeton University), Professor*
Experimental and theoretical protein dynamics, kinetics of biological self-assembly, including sickle cell and Alzheimer's disease.

Leonard X. Finegold, Ph.D. *(University of London), Professor*
Biological physics and granular physics.

Robert Gilmore, Ph.D. *(Massachusetts Institute of Technology), Professor*
Applications of compact and non-compact Lie algebras for problems in nuclear, atomic, and molecular physics; nonlinear dynamics and chaos and the analysis of chaotic data.

David M. Goldberg, Ph.D. *(Princeton University), Assistant Professor*
Theoretical and computational cosmology, extragalactic astrophysics, parallel computing.

Richard D. Haracz, Ph.D. *(Wayne State University), Professor and Associate Provost for Research and Dean of Graduate Studies*

Frederick B. House, Ph.D. *(University of Wisconsin), Professor*
Satellite meteorology, earth energy budget.

Arthur Joblin, Ph.D. *(Drexel University), Assistant Professor*
Physics education.

Paul Kazmarczik, Ph.D. *(Temple University), Professor Emeritus*

Charles E. Lane, Ph.D. *(California Institute of Technology), Associate Professor*
Experimental tests of invariance principles and conservation laws, experimental search for magnetic monopoles and high-energy cosmic neutrinos, solar neutrinos and neutrino oscillations.

Donald C. Larson, Ph.D. *(Harvard University), Professor Emeritus*

Teck-Kah Lim, Ph.D. *(University of Adelaide), Professor*
Structures and dynamics of small nuclear and molecular systems, spin-polarized quantum systems, physics in two dimensions. Physics education.

Arthur E. Lord, Ph.D. *(Columbia University), Professor Emeritus*

Peter MacNeice, Ph.D. *(University of Cambridge), Research Associate Professor*
High-performance computing, magneto-hydraulics, adaptive mesh refinement algorithm on parallel platform (PARAMESH).

James McCray, Ph.D. *(California Institute of Technology), Professor Emeritus*

Stephen L. W. McMillan, Ph.D. *(Harvard University), Distinguished Professor*

Stellar dynamics, large-scale computations of stellar systems, and high-performance special-purpose computers.

Lorenzo M. Narducci, Ph.D. *(University of Milan), Francis K. Davis Professor*
Laser physics, quantum optics, nonlinear dynamical systems, spatial patterns.

Richard I. Steinberg, Ph.D. *(Yale University), Professor*
Experimental tests of invariance principles and conservation laws, experimental search for magnetic monopoles and high-energy cosmic neutrinos (MACRO experiment at Gran Sasso Laboratory, Italy), solar neutrinos and neutrino oscillations (CHOOZ project).

Somdev Tyagi, Ph.D. *(Brigham Young University), Professor*
Physics of high-temperature superconductivity, magnetic properties of thin sputtered films of amorphous metallic alloys, fiber-optical sensors.

Michel Vallières, Ph.D. *(University of Pennsylvania), Professor and Head of the Department*
Shell-model and mean field studies of nuclei on and off beta-stability, chaotic scattering, computational physics.

T. S. Venkataraman, Ph.D. *(Worcester Polytechnic Institute), Professor*
Material engineering and physics.

Michael S. Vogeley, Ph.D. *(Harvard University), Assistant Professor*
Cosmology, extra-galactic astrophysics, Hubble Space Telescope, Sloan Digital Sky Survey.

Guoliang Yang, Ph.D. *(Southern Illinois University), Assistant Professor*
Experimental protein dynamics studies, atomic force microscope technique.

Jian-Min Yuan, Ph.D. *(University of Chicago), Professor*
Nonlinear dynamics and chaos in atomic and molecular systems, protein folding.

Facilities
Astrophysics Survey Facility

The facility duplicates the Sloan Digital Sky Survey data locally. Facilities include SGI and Linux workstations and a multi-TB database server, with latest object-oriented database management and query software.

Numerical Astrophysics Facility

Emphasis is on cosmology, matter distribution in the universe, gravitational lensing, and globular cluster modeling. Sloan Digital Sky Survey data is analyzed locally on a compute/data center with a large-RAID-array disk farm. The group also uses the 96-CPU Beowulf system as described below. The globular cluster modeling is performed on GRAPE board (the fastest computer in the world) connected to a dual AMD front-end server harboring a large-RAID-array disk farm. Facilities also include a variety of Linux workstations, with fast access to National Supercomputer Clusters.

Observatory

A 16-inch Meade telescope is the key feature of a newly revamped local observatory on campus. Students use the observatory for coursework, independent observation projects, and hardware development.

Biophysics Laser Laboratory

Research is focused on the development of pulsed laser instrumentation systems and their application to the measurement of time-dependent biophysical and biochemical processes. Laser photolysis of caged-ATP, caged-Ca2+, and caged neurotransmitters are being used in the study of the molecular mechanisms of muscle contraction and neuron communication. Facilities include frequency-doubled ruby, neodymium-glass, liquid dye, solid-state holmium-YLF and erbium-glass lasers. At the National Synchrotron Light Source at Brookhaven National Laboratory pulse lasers are used to initiate processes, such as the cross-bridge cycle in muscle contraction, which are followed by time-dependent X-ray diffraction. In collaboration with the National Institute for Medical Research in London, post-synaptic events are studied by two-photon absorption of 200-femtosecond pulses.

Modulated Excitation Kinetics Laboratory

For studying the internal dynamics of biomolecules, the laboratory includes a 5-W argon ion laser, cw dye laser, optical modulator, various optical components for operation at all wavelengths, and data acquisition system based on a Macintosh computer interfaced to a two-phase lock-in amplifier.

Spatially Resolved Kinetics Laboratory

For studying the spatially nonuniform kinetics of biomolecular self-assembly, this laboratory includes a 5-W argon ion dye laser, pulsed N2-dye laser, CCD detector, and various optical components interfaced to various Macintosh computer systems.

Protein Dynamics Laboratory

This laboratory is dedicated to the study of the structure and mechanical properties of proteins. An Atomic Force Microscope (AFM) is used to mechanically stretch individual proteins and measure the force and ensuing changes in conformations. The laboratory is fully equipped with ancillary equipment to prepare and manipulate samples.

Preparative Facilities for Biophysical Experiments

This general-use facility includes a cold chamber, Beckman centrifuge, Mettler balance, fume hood, large nitrogen glove box, phase-contrast microscope, digital pH meter, and a Hewlett-Packard diode spectrophotometer interfaced to a personal computer.

Molecular Graphics and Computational Facilities

INDIGO 2, OCTANE graphic workstations, and four-processor ORIGIN 200 server are available for dynamics calculations and graphics displays.

Magnetic Materials and Thin-Film Laboratory

Research is being conducted on amorphous magnetic thin films, fiber optical sensors, and high-T superconductors. Facilities include a Varian X-band ESR spectrometer, vibrating sample magnetometer, Kerr-effect magnetometer, Mössbauer spectrometer, AC-susceptometer, and a variety of thin-film deposition apparatus using techniques including thermal evaporation, E-beam evaporation, and RF- and DC-triode magnetron sputtering.

Particle Physics Detector Development Laboratory

This facility provides experimental support for a research program in non-accelerator particle and nuclear physics, performing tests of invariance principles and conservation laws and searches for neutro oscillation and high-energy neutrinos. Facilities include modern data acquisition electronics, including numerous CAMAC and NIM modules, various photomultiplier tubes, oscilloscopes, pulse height analyzers, a pulsed tunable dye-laser, a high-sensitivity long-path spectro-photometer, and a 600-liter liquid scintillation test tank.

Surface Science Laboratory

Emphasis is on studies to relate static structure and dynamic processes at solid surfaces and interfaces at the atomic level. Facilities include a scanning tunneling microscope, an Atomic Force Microscope, and a surface analysis system for ultraviolet photoemission spectroscopy.

Laboratory for High-Performance Computational Physics

This undergraduate and graduate teaching facility also provides support for various numerically intensive research projects. Facilities include a four-processor MOSIX cluster and 15 independent Pentium workstations all running Linux, configured in a subnet and having full network access.

Drexel Beowulf Parallel Computer

Two clusters of off-the-shelf computers act as a parallel computer. The first cluster encompasses 32 dual–Pentium III 450-MHz CPUs, with 512 (256) megabytes of RAM and a 40-GB local disk, connected via a fast-Ethernet switch; this cluster is used for nuclear physics, biophysics, astrophysics, and nonlinear dynamics studies.

The second cluster is a new server to support astrophysics research. It consists of 48 dual AMD CPUs, with 2 gigabytes of RAM and large local disks. The cluster is linked via two switched fast-Ethernet networks working in parallel.

General Facilities

The College of Arts and Sciences shops provide facilities for custom design and fabrication of electronics and computer components and glassware.

National and International Collaborations

Collaborations with national and international research centers include active collaboration and experiments with Brookhaven National Laboratory (National Synchrotron Light Source), Frascati National Laboratory (Italy), Gran Sasso Laboratory (Italy), IBM Research Center, Instituto Nazionale di Ottica (Italy), MOSIX facilities at Hebrew University, NASA Langley Research Center.

Clinical Psychology

Drexel University offers the Ph.D. degree in clinical psychology with the primary goal of training clinical psychologists in the scientist-practitioner model. This model places equal emphasis on clinical research and the application of scientific principles. Students receive an appropriate, broad education in preparation for entry-level practice in professional psychology. This education includes training in intervention and assessment, as well as an introduction to the science and practice of clinical psychology. The program is accredited by the American Psychological Association.

To advance this integrated approach, the study of theory is complemented by ample opportunities to develop expertise in the application of knowledge. Drexel students conduct research with an applied emphasis, and they incorporate the knowledge of science and research in their practice. Clerkships and an internship are a central component of the program. The degree must be pursued on a full-time basis. Four to six new students are admitted each year.

This highly selective program is further distinguished by its emphasis on the emerging, substantive area of clinical neuropsychology. Other strengths include training in the teaching of psychology and in emerging issues in gerontology, pediatrics, and brain injury, and a focus on cross-disciplinary thinking. Drexel is developing stature as a center for research into the neuropsychology of aging, particularly the effects of degenerative neurological processes.

A part-time postdoctoral fellowship is also offered.

Doctoral Program
All students are admitted with the expectation that they intend to complete the Ph.D. degree. Drexel University does not offer a terminal master's degree in psychology. However, before advancing to doctoral-level studies, students must earn the M.S., including completion of a master's thesis. Admitted students who hold a bachelor's degree are expected to complete both the master's and post-master's portions of the Drexel curriculum. Applicants who already hold a master's from another university may be admitted with post-master's status if their graduate-level preparation is deemed equivalent to the master's portion of the Drexel curriculum.

Requirements for Students Enrolling with a Bachelor's Degree

For those entering with a bachelor's degree, the Ph.D. program requires approximately five years to complete. The first two years of training correspond to the master's-level studies: basic science and neuroscience courses intended to build a broad understanding of the theoretical foundations of brain-behavior relationships. Entry-level assessment and intervention skills are also developed.

By the end of the first two years of study, students should have completed 45 credits of coursework, maintained a GPA of at least 3.5, developed and defended a thesis, and completed 1,200 hours of practicum experience in the form of a clinical clerkship. Students demonstrating satisfactory performance in these areas will be admitted to post-master's status.

Requirements for Students Who Already Hold a Master's Degree

Students entering with a master's degree from another university usually complete the Ph.D. requirements in four years. The master's degree should have included an experimental thesis. Students lacking this prerequisite will still be considered for admission, but such students will be required to complete a research project equivalent to the Drexel master's thesis. In addition, students must demonstrate a GPA of at least 3.5 in master's-level courses in order to be accepted for post-master's status.

Requirements for Completing the Ph.D.

Coursework at the doctoral level consists of advanced instruction in the broad-based conceptual foundations of clinical psychology and brain-behavior relationships. Students further develop assessment skills, receive additional clinical training, and gain experience through advanced clinical placements. Systems of case conceptualization are reviewed and related to assessment and intervention strategies.

After students are accepted into the post-master's portion of the curriculum, the following requirements must be met: 45 credits of additional coursework, a comprehensive exam, development and defense of a dissertation, 1,200 hours of additional practicum training, and 1,800 hours of internship training. Students must remain in good standing in the program (i.e., maintain a 3.5 GPA). If placed on clinical or academic probation, students must complete the necessary remedial requirements.

Curriculum

The Drexel Ph.D. psychology curriculum has been developed in accordance with several factors. It follows the scientist-practitioner model and conforms to APA guidelines on the accreditation of doctoral clinical psychology programs. The program also considers state licensing guidelines, as well as various published curricular recommendations on advanced education, training, and credentialing in clinical psychology and neuropsychology.

The following section outlines the course requirements for the Drexel Ph.D. program and the sequence for meeting these requirements within a five-year period. In general, students must earn a minimum of 90 credits (most courses carry three credits each). Students usually enroll in a minimum of 27 course credits during the first year, 18 credits during the second and third years, 18 credits during the fourth year, and eight credits during the final year. (These totals include credits earned for thesis/dissertation research and clerkship/internship experience.)

Drexel University operates on a quarter system, with four equal-length terms per year. The psychology program does not require summer coursework, freeing students to use that term for research projects or continuations of clinical clerkship training.

The coursework is divided into two major components: the study of the foundations of psychology, which is the evolving body of knowledge in the discipline of psychology, and clinical and professional training, which is related to specific skills in clinical psychology and clinical neuropsychology. Each of these two broad areas is composed of various subcategories.

The full requirements listed here apply to those students completing the 90-credit

post-bachelor's program. When scheduling courses, students receive more specific guidance as to which studies are most appropriate at the master's or post-master's level. Those entering the program with post-master's status generally focus on courses numbered at the 600 level and higher.

Foundations of Psychology

History and Systems

Course		Credits
PSY 712	**History and Systems of Psychology**	3.0

Foundations of Psychological Evaluation/Measurement

Courses		Credits
PSY 522	**Psychological and Intellectual Assessment**	3.0
PSY 542	**Neuropsychological Assessment**	3.0
PSY 620	**Personality Assessment**	3.0

Statistics/Research Methods

Courses		Credits
PSY 510	**Research Methods in Psychology**	3.0
PSY 610	**Data Analysis in Psychology**	3.0
PSY 710	**Multivariate Methods in Psychology**	3.0
PSY 898	**Thesis in Psychology***	3.0
PSY 998	**Dissertation in Psychology**	4.0

***Students who enter with a nonthesis master's degree must conduct a research project similar in scope to a thesis.**

Biological Bases of Behavior

Courses		Credits
PSY 530	**Principles of Neuroscience**	3.0
PSY 540	**Principles of Neuropsychology**	3.0

One of the following electives		3.0
PSY 630	**Psychopharmacology**	
PSY 632	**Sensory and Motor Systems**	
PSY 865	**Special Topics in Psychology**	

Cognitive/Affective Bases of Behavior

Courses		Credits
PSY 512	**Cognitive Psychology**	3.0

One of the following electives		3.0
PSY 514	**Learning Theories**	
PSY 612	**Psychology of Human-Computer Interface Design**	
PSY 614	**Problem-Solving and Creativity**	
PSY 616	**Motivation and Emotion**	
PSY 865	**Special Topics in Psychology**	

Individual Differences

Courses		Credits
PSY 520	**Psychopathology**	3.0
	One of the following electives	3.0
PSY 516	**Developmental Psychology**	
PSY 621	**Theories of Personality**	
PSY 865	**Special Topics in Psychology**	

Social Bases of Behavior

Courses		Credits
Multicultural Perspectives on Client Populations*		**3.0**
One of the following electives		**3.0**
PSY 518	**Social Psychology**	
PSY 618	**Psychology of Loss and Bereavement**	
PSY 718	**Social Factors in Health and Aging**	
PSY 865	**Special Topics in Psychology**	

***Please contact the department for course number and description**

Clinical and Professional Training

General Foundations of Practice

Courses		Credits
PSY 520	**Psychopathology**	3.0
PSY 524	**Professional Issues and Ethics**	3.0

Foundations of Psychological Evaluation/Measurement

Courses		Credits
PSY 522	**Psychological and Intellectual Assessment**	3.0
PSY 542	**Neuropsychological Assessment**	3.0
PSY 620	**Personality Assessment**	3.0

Advanced Professional Training - General Clinical

Courses		Credits
PSY 721	**Principles of Psychotherapy**	3.0
PSY 722	**Psychotherapeutic Techniques**	3.0
PSY 999	**Internship**	4.0
One of the following electives		**3.0**
PSY 646	**Psychological Assessment of Children and Adolescents**	
PSY 648	**Forensic Psychology**	
PSY 720	**Medical Psychology**	

PSY 821	**Family and Group Therapy**
PSY 824	**Psychotherapy with Children and Adolescents**
PSY 850	**Psychology of Disability**

Advanced Professional Training in Clinical Neuropsychology

Courses	Credits
PSY 642 **Case Analysis and Integration**	3.0

One of the following electives	3.0
PSY 746	**Neuropsychological Evaluation and Intervention: Children and Adolescents**
PSY 843	**Neuropsychological Evaluation and Intervention: Head Trauma**
PSY 845	**Neuropsychological Evaluation and Intervention: The Elderly**
PSY 854	**Psychology of Rehabilitation**

Clinical Experience

Professional experience gained through clerkships and internships is an integral part of the program.

Clerkships

The goal of the clerkship is to provide a breadth of training, as well as opportunities to develop specific skills in clinical psychology with an emphasis or specialty in neuropsychology. Students are placed in medical centers, general hospitals, geriatric centers, psychiatric facilities, and rehabilitation hospitals throughout the Philadelphia area. These clerkships are typically scheduled in the second and third years of the program. These 12-month placements usually require 24 hours of work per week. Students are exposed to direct patient care and applied research endeavors under the supervision of practicing clinical psychologists and clinical neuropsychologists. Sites for recent clerkships include:

- *Children's Seashore House*
- *Clinical Neuropsychological Associates*
- *Hahnemann University Hospital, Department of Neurology*
- *Hospital of the University of Pennsylvania, Department of Psychology and Department of Neurology*
- *Kirkbride Center*
- *MossRehab, Drucker Brain Injury Center*
- *Thomas Jefferson University Hospital, Department of Rehabilitation Medicine and Department of Neurology*
- *Sacchetti and Associates*

Internships

The internship is a full-time endeavor, lasting for a full year (a minimum of 1,800 hours); under some circumstances, half-time internships for two years may be permitted. No more than two students may apply to any one internship site during the same year. Internship sites attended by recent graduate students include:

- *Coatesville Veterans Administration Medical Center, Pennsylvania*
- *Eastern Virginia Medical School, Norfolk, Virginia*
- *Friends Hospital, Philadelphia*
- *Kennedy-Krieger Institute, Baltimore, Maryland*
- *Long Island Jewish Medical Center, New York*
- *Minneapolis Children's Medical Center, Minneapolis, Minnesota*
- *Mt. Sinai Medical Center, New York City*
- *Norristown State Hospital, Norristown, Pennsylvania*
- *Portsmouth Navy Medical Center, Virginia*
- *Tulane Medical School, New Orleans*
- *University of Arizona School of Medicine, Tucson, Arizona*
- *University of Oklahoma Health Science Center, Oklahoma*
- *University of Virginia Health Services Center, Charlottesville, Virginia*
- *Yale University School of Medicine, New Haven, Connecticut*

Research Experience

The program is housed within Drexel's Department of Psychology. Students benefit from the broad range of research interests represented, as well as from the opportunities to develop interdisciplinary initiatives. The following dissertation topics have been pursued by Drexel psychology students:

- *Limb Apraxia in Alzheimer's Disease*
- *Construct Validity of the Mattis Dementia Rating Scale:A Factor Model*
- *Right Hemisphere Deficits in Visual-Spatial Memory*
- *A Cluster Analysis of MMPI Profiles of Pain Patients*
- *Experimentally Induced Fatigue in Severe Head Injury Survivors*
- *Field Dependent Behavior: A Measure of Executive Control Dysfunction in Schizophrenics*
- *Predictors of Outcome in Chronic Pain Patients*
- *Verbal Memory and Resting Cerebral Metabolism in Schizophrenia*
- *Attention Deficit Subtypes on ADHD and Their Relationship to Cognitive Functioning and Historical Variables*
- *Neuropsychological Patterns of Positive and Negative Symptoms in Schizophrenia*
- *Executive Function in Turner Syndrome*

Gerontology Component

Of particular importance to Drexel's graduate psychology program is the expertise of faculty in the integration of clinical psychology, neuropsychology, and gerontology. This integration has fostered a specific Drexel research focus on the neuropsychology of aging, particularly the effects of degenerative neurological processes. The faculty's interdisciplinary expertise allows students to become sensitive to methodological and theoretical differences in assessing and intervening with the elderly.

Teaching Experience

All psychology graduate students are expected to become highly qualified teachers. Receiving a teaching assistantship confers an obligation on students to fulfill the role of teacher at the highest possible level of performance. Thus, all students are required to participate in undergraduate teaching in a structured environment for their first year. Optional teaching experiences include advanced teaching assistantships, which involve teaching at the graduate level, the teaching of core undergraduate psychology courses, and enrolling in courses that focus on advanced teaching techniques.

Admissions Requirements

Newly admitted students begin the program in September. All application materials must be received by the previous January 1 so that admission decisions can be made and offers extended by April 1. Only applications for full-time status are considered. The general University requirements for admission include a minimum 3.0 GPA (on a 4.0 scale) for the last two years of undergraduate study. Applicants to the graduate program in psychology are also required to submit scores from the Graduate Record Examination (GRE) general tests.

Admission is competitive and is limited to four to six students per year. There are currently 28 full-time students enrolled, representing various ethnic and cultural groups.

Various factors are considered in choosing students. These include background in psychology, potential for good performance as a psychologist in clinical and research work, undergraduate (and, if applicable, graduate) GPA, GRE scores, and letters of recommendation. The preferred GRE scores are a minimum of 500 on both the verbal and quantitative portions; the average combined score of admitted students is approximately 1,200.

Assistantships and Financial Aid

All graduate students in the psychology program are supported financially through research, graduate, and teaching assistantships and fellowships. Assistantships offer complete tuition remission and a stipend (approximately $6,000 to $7,000 per year). First-year students are typically offered teaching assistantships with responsibilities for undergraduate teaching; second- and third-year students usually hold graduate assistantships with clinical responsibilities; fourth-year students generally have advanced teaching and research assistantships. The fifth or final year of the program usually involves the internship, with most internship sites providing some form of compensation.

Drexel’s Financial Aid Office can provide information on non-departmental aid, such as student loan programs.

Post-Doctoral Fellowship

The department awards the Advanced Professional Certificate in Neuropsychology, designed for individuals trained in clinical or school psychology or related fields.

The fellowship is a part-time program that requires one to two years for completion. It cannot be considered equivalent to a one-year full-time fellowship. It is, however, an appropriate option for individuals who are, for personal and professional reasons, not able to pursue full-time post-doctoral study. The program assumes that post-doctoral fellows already hold extensive clinical training; thus, the department cannot admit individuals whose Ph.D. work focused on nonclinical areas of psychology.

The requirements include a minimum of six courses, selected in consultation with faculty advisors. This coursework provides a strong grounding in neuropsychological issues. Fellows also complete a minimum of 500 hours of supervised clinical training in neuropsychology, either at one of the training institutions already associated with the program or at a site arranged for by the fellow.

Professionals interested in this option should contact the department for information on admissions requirements.

Faculty Research Interests

Lamia P. Barakat, Ph.D. *(University of South Carolina), Assistant Professor of Psychology and Licensed Psychologist and Director of Clinical Training*
Pediatric and clinical child psychology, psychosocial factors in chronic childhood illness.

James L. Calkins, Ph.D. *(Purdue University), Associate Professor of Psychology*
Principles of learning, experimental psychology, history and systems of psychology, invertebrate neurochemical and neurobehavioral models of compulsive and addictive behavior, role of placebo and suggestion in treatment.

Douglas L. Chute, Ph.D. *(University of Missouri), Professor of Neuropsychology and Licensed Psychologist*
Head injury assessment and rehabilitation, educational neuropsychology, behavioral neuroscience, teaching in psychology.

John V. Colamosca, Ph.D. *(Wayne State University), Assistant Professor of Psychology*
Personality and social psychology, coping with loss and grief.

Anthony P. Glascock, Ph.D. *(University of Pittsburgh), Professor of Anthropology*
Home health care, functionality of older adults, quality-of-life issues in the elderly.

Julia G. Hall, Ph.D. *(University of Pennsylvania), Professor of Sociology*
Gerontological service delivery systems; research methods; special environmental factors for the elderly, disabled, and cognitively impaired; aging in prison populations.

Thomas T. Hewett, Ph.D. *(University of Illinois), Professor of Psychology*
Human-computer interaction, cognitive psychology, computer applications, history and systems of psychology.

Barbara G. Hornum, Ph.D. *(Bryn Mawr College), Associate Professor of Anthropology and Associate Provost and Dean of Undergraduate Studies*
Patient and support networks, ethnic factors in treatment, gerontological issues.

Jacqueline D. Kloss, Ph.D. *(Binghamton University), Assistant Professor of Psychology*
Health psychology, clinical psychology.

David M. Kutzik, Ph.D. *(Temple University), Associate Professor of Sociology*
Patient and support networks, ethnic factors in treatment of the elderly, factors in residential choice, cross-cultural and comparative aging, research methods.

Usha Menon, Ph.D. *(University of Chicago), Assistant Professor of Anthropology*
Cultural anthropology; issues in health, family, and gender.

Elizabeth McLean Petras, Ph.D. *(State University of New York at Binghamton), Associate Professor of Sociology*
International labor migration, immigrant and low-income communities, urban sociology, Third World development, multicultural perspectives.

Douglas V. Porpora, Ph.D. *(Temple University), Professor of Sociology and Department Head*
Philosophy of the mind, political economy of health care, culture, statistics.

Arthur Shostak, Ph.D. *(Princeton University), Professor of Sociology*
Industrial sociology, futuristics, social change and social planning, social implications of 20th-century technology, management and technology.

Mary Spiers, Ph.D. *(University of Alabama at Birmingham), Associate Professor of Psychology, Licensed Psychologist, and Director of Graduate Programs in Psychology*
The neuropsychology of everyday memory, medication adherence among the elderly, olfaction and women's cognitive health.

Burton A. Weiss, Ph.D., FPPR *(Princeton University), Associate Professor of Psychology and Licensed Psychologist, Board Certified Prescribing Psychologist*
Comparative and physiological psychology, brain and sensory functioning, the evolution of behavior, psychopharmacology, forensic psychology.

Eric A. Zillmer, Psy.D. *(Florida Institute of Technology), Professor of Psychology, Licensed Psychologist, and Director of Athletics*
Psychological assessment (neuropsychological, cognitive, personality), psychiatric and neurological disorders, behavioral medicine, neurogerontology, mathematical modeling, sports psychology, psychology of genocide.

Publication Management

General Information

The goal of the M.S. program in publication management is to produce managers who understand the capabilities and limitations of the available technology and can make managerial decisions based on that understanding. Students enter the program from diverse undergraduate backgrounds, including liberal arts, business administration, journalism, communications, technical writing, and information studies. The program builds on the individual's undergraduate content base by providing knowledge about the key elements of the publishing process needed by a publishing executive. The program also serves the needs of individuals already employed in the printing or publishing industry who are seeking to update or broaden their knowledge.

Students completing the program may find career opportunities in the management of traditional publishing companies as well as in corporate communication areas of a broad range of business and education. Entrepreneurial opportunities provide another area of career development.

All courses in the program are offered in the evening on a part-time or full-time basis. The curriculum comprises courses in technical and science writing and editing, product acquisition, design, production, and printing technology offered through the College of Arts and Sciences and business management and marketing courses offered through the LeBow College of Business. After admissibility to Drexel graduate studies has been determined, applicants are selected on the basis of college transcripts, a written statement of professional goals and objectives, references, and a personal interview with the graduate advisor.

Graduate assistantships are available to selected students. Assistantships provide professional experience, tuition waiver, and stipend. Contact the University Financial Aid Office for information regarding work-study arrangements and student loans.

Requirements

Graduation from the program requires the successful completion of all program pre- and co-requisites and 45 credits of graduate coursework. The graduate coursework includes 39 credits of required courses and 6 credits of electives. Electives can be selected, with faculty advisement, from graduate courses in the student's interest that meet the objectives of the program. Independent study and additional credits in the independent project are available as elective options.

Curriculum

Courses		Credits
ACCT 602	**Managerial Accounting**	3.0
COM 510	**Technical Writing**	3.0
COM 570	**Technical and Science Editing**	3.0

MKTG 620	**Marketing Strategy and Planning**	3.0
MKTG 638	**New Product Planning, Strategy, and Development***	3.0
ORGB 602	**Individual Behavior in Organizations**	3.0
ORGB 622	**Group and Interpersonal Behavior in Organizations**	3.0
PMGT 630	**The Publishing and Printing Industries**	3.0
PMGT 631	**Art and Illustration Reproduction**	3.0
PMGT 635	**Small Publication Production**	3.0
PMGT 730	**Book Production**	3.0
PMGT 731	**Computer Image Generation and Telecommunication**	3.0
PMGT 735	**Publication Budgeting and Estimating**	3.0
	Electives	6.0

***MKTG 638 should be taken after MKTG 620 if possible.**

Science, Technology, and Society

General Information

The increasingly complex nature of modern life has steadily eroded the distinctions traditionally made between social and technical issues. Leaders among scientists, engineers, policy-makers, managers, investors, and educators must base their decisions on a diverse array of data, new tools for gathering and evaluating this data, integrated systems of information, and interdisciplinary approaches to problem-solving. In an era of expanding global investment and complex regulation, opportunities will accrue to those who can identify potential problems early and formulate multifaceted, long-term, and viable solutions.

The graduate program in Science, Technology, and Society (STS) targets this new leadership cadre. STS at Drexel integrates the study of history, science and technology, public policy, and contemporary social and political issues. It combines core courses in the history of science and technology with classes that focus on gender and race, democratic institutions, ethics, and future challenges to industry and government. The program also provides a unique international orientation, which recognizes the crucial context of globalization in the advancement of science and technology and the broad implications of scientific research and innovation in the politics and history of the modern world.

Prospective students for the master's in STS see this educational opportunity as an essential factor in their skill enhancement and career advancement. They are recent college graduates in the social sciences, humanities, natural sciences, and engineering; middle and high school teachers; and professionals in businesses, city and state government offices, and area hospitals. Students can attend full time or part time and complete all coursework in the evening.

Applicants to the program must meet the general requirements for admission to graduate studies at Drexel. Prospective students must also submit a 500-word essay explaining why they want to enter the program. These statements are read carefully by the faculty screening committee to evaluate each applicant's sense of purpose. Entering students begin during the fall quarter.

Curriculum

The M.S. degree in STS requires 45 credits of coursework. At least 36 credits must be history/politics courses. Required courses total 27 credits (including a 3-credit seminar, a 3-credit practicum, and 6 credits of research and writing for the thesis, which may be tied to the practicum). Remaining credits are chosen from a list of electives.

Basic requirements		Credits
HIST 501	**Introduction to Science, Technology, and Society**	3.0
HIST 585	**Technology in Historical Perspective**	3.0
HIST 586	**Gender and Technology**	3.0
PSCI 555	**International Political Economy**	3.0
PSCI 571	**Science and Technology Public Policy**	3.0

Advanced requirements	Credits

HIST/ PSCI 597	**Seminar in Science, Technology, and Society**	3.0
HIST 598	**Practicum: Science and Technology in Action**	3.0
HIST/ PSCI 599	**M.S. Thesis**	6.0

Electives		**Credits**
	Suggested electives (at least three courses)	9.0
HIST 583	**History of Medicine and Disease**	
HIST 590	**Themes in the History of Science**	
HIST 591	**Themes in the History of Technology**	
PSCI 541	**Technology in Developing Countries**	
PSCI 555	**International Political Economy and Technology**	
PSCI 557	**Globalization and Transition**	
PSCI 570	**International Environmental Policy**	
PSCI 573	**Gender, Race, and Science**	
PSCI 574	**Alternative Policy Perspectives**	
PSCI 575	**Appropriate Technology and Development**	

Remaining electives (may include the following)		**9.0**
COM 650	**Telecommunications Policy**	
COM 690	**Grant Writing**	
ENVR 880	**Environment and Society**	
MGMT 602	**Management and Technology**	
PSY 612	**Human-Computer Interaction**	

Faculty Research Interests

Eric Dorn Brose, Ph.D. *(Ohio State University), Professor*
History of science and technology.

Christian Hunold, Ph.D. *(University of Pittsburgh), Assistant Professor*
Environmental policy, public policy.

Roy Kim, Ph.D. *(University of Pennsylvania), Associate Professor*
International political economy and technology.

Julie Mostov, Ph.D. *(New York University), Associate Professor*
Globalization and transition.

Sami Ofeish, Ph.D. *(University of California at Los Angeles), Assistant Professor*
Technology in developing countries.

Erik Rau, Ph.D. *(University of Pennsylvania), Visiting Assistant Professor*
History of technology and engineering.

Richard Rosen, Ph.D. *(Case Western Reserve University), Associate Professor*
History of science and technology, appropriate technology.

Amy Slaton, Ph.D. *(University of Pennsylvania), Assistant Professor*
History of technology and engineering.

Kathryn Steen, Ph.D. *(University of Delaware), Assistant Professor*
History of technology and engineering, history of American business.

The School of Education

General Information

The School of Education offers Pennsylvania Department of Education-approved programs to certify students who already hold bachelor's degrees to be teachers in elementary education (with an emphasis on mathematics, science, and technology), secondary education (in biology, chemistry, earth and space science, environmental education, general science, mathematics, or physics), and K-12 (instructional technology specialist and library science). Principal and superintendent certifications are also available. Individuals who complete the minimum requirements receive a teaching certificate and have the option to continue coursework to fulfill requirements in the graduate Science of Instruction master's degree program.

The master's degree program is also available to those who already have teacher certification and/or do not wish to obtain a teaching certificate. Students who would like to pursue the instructional technology specialist teacher certification must already have Pennsylvania Instructional I certification or appropriate equivalent.

Graduate Intern Teaching Certificate

The part-time Graduate Intern Teaching Certificate program offers pedagogy coursework necessary for teacher certification in the evening so that students may teach or work during the day. An exception is EDUC 540 (Field Experience), which requires the student to spend a minimum of three hours per morning for 10 weeks with a cooperating teacher in an appropriate elementary or secondary school classroom.

Admissions Requirements

Applicants for the Graduate Intern Teaching Certificate program must complete an interview with a teacher education advisor before completing a graduate application. During this interview the applicant's transcripts are evaluated in relation to Pennsylvania state standards for the specific certification area. If coursework is dated, a content exam or additional coursework may be required. Life experience that demonstrates knowledge of the content area will be considered.

Additional coursework in the content area may be required to meet certification standards. In addition, applicants must meet the general admissions requirements for graduate studies at Drexel University.

Program Requirements

Graduate Intern Teaching Certificate applicants for elementary certification may come from a variety of undergraduate backgrounds. Applicants for secondary and K-12 certification must have a bachelor's degree in an area related to that in which they intend to become certified. Minimum coursework requirements include 23 credits of pedagogy, which may be incorporated into the graduate Science of

Instruction master's degree program or into the electives portion of another approved Drexel master's degree program in the subject area of certification.

Intern teachers may obtain a full-time teaching position after they have been recommended for the Pennsylvania Department of Education Intern Teaching Certificate. To be recommended, students must be admitted into the Drexel graduate program, obtain at least a B in EDUC 520 (Professional Studies in Instruction) and in EDUC 540 (Field Experience), and obtain the necessary scores on the appropriate sections of the Praxis Series assessments through the Educational Testing Service (ETS). Completion of all required pedagogy coursework with at least a B in each and a B average in required content courses and passing Praxis Series scores will satisfy requirements for Pennsylvania Instructional I Certification.

Title II Reporting

In compliance with Title II, Section 207, of the Higher Education Act of 1998 and General Standards for the Institutional Preparation of Professional Educators (Chapter 354), pass rates on the Praxis Series Exam for students prepared as teachers by Drexel University are available by contacting the School of Education at 215-895-6770.

Master of Science Program

The Master of Science in the Science of Instruction program builds on Drexel's discipline-based teacher education program at the undergraduate level and on the Graduate Intern Teaching Certificate program at the graduate level. Coursework for the Graduate Intern Teaching Certificate program forms the core of this master's degree; the same requirements for Intern and Instructional I Certification apply.

The program is designed primarily for those who wish to teach high school mathematics, science, and/or technology, especially as a subsequent career, although the degree may be obtained without completing the requirements for a teaching certificate. The program is especially appropriate for those who already possess a degree in mathematics, science, or engineering. In addition, the program is relevant to individuals in careers such as business and communications who wish to teach at the elementary grade levels. The program is designed for part-time as well as full-time study. Full-time students can usually complete the program in one year. Both the Pennsylvania Intern Certificate and the Instructional I Certificate may be attained through this program before the degree requirements are met.

The graduate Science of Instruction program incorporates current research on teaching and provides in-depth preparation in pedagogy, curriculum development, heuristic diagnostic teaching, implications of learner and task characteristics for instructional design, the latest techniques in evaluation of instruction, and use of interactive technology in instruction. The student is provided opportunities to synthesize theoretical and practical knowledge through field study in elementary and secondary classrooms. Students seeking a teaching certificate are required to engage in classroom research as a component of several of the required courses. The main goal of the program is to prepare teachers who will strengthen mathematics, science, and technology instruction in kindergarten through high school.

Admissions Requirements

Applicants for the master's degree in the Science of Instruction must complete an interview with a teacher education advisor before completing a graduate application. During this interview the applicant's transcripts are evaluated in relation to Pennsylvania state standards for certification or an add-on certification area and for formalizing a specified program of study. If coursework is dated, a content exam may be required. Life experience that demonstrates knowledge of the content area will be considered. Additional coursework in the content area may be required to meet certification standards. In addition, applicants must meet the general admissions requirements of graduate studies at Drexel University. A 3.0 grade point average in content coursework related to the candidate's area of certification is required.

Degree Requirements

A minimum of 45 credits is required for students with or without prior certification (including 15 credits of professional electives).

Core Courses

At a minimum, 23 pedagogy credits will be required from the core courses for those without prior teacher certification. Students with prior certification or those seeking an add-on certification will select 11 credits from the core courses.

Courses	Credits
EDUC 520 **Professional Studies in Instruction***	3.0
EDUC 522 **Evaluation of Instruction**	4.0
EDUC 523 **Diagnostic Teaching**	4.0
EDUC 524 **Current Research in Curriculum and Instruction**	3.0
EDUC 525 **Multimedia in Instructional Design**	3.0
EDUC 526 **Language Arts Processes**	3.0
EDUC 540 **Field Experience***	3.0

***Not available to those with prior teacher certification.**

Content Categories

For students without prior teacher certification, 7 credits are required, selected from the following content categories. (A list of suggested courses is available from the department.) Students with prior certification or those seeking add-on certification select 19 credits from the content categories.

A. Mathematics and science

B. Technological pedagogy

C. Applied pedagogy

Evaluation of transcripts by a program advisor in relation to Pennsylvania state standards determines the required content courses for initial certification and add-on certification. To satisfy state certification requirements, undergraduate courses may be taken in instances where graduate courses are not appropriate. These undergraduate courses will not satisfy graduate degree requirements. However, they will satisfy certification requirements and may satisfy requirements for salary increments in certain school districts. For those with prior certification who do not wish add-on certification, but desire to further professional competence, a distribution of courses from areas A, B, and C is selected under advisement on an individual basis.

Professional Electives

Students with or without prior certification select 15 credits of professional electives. Professional electives are selected with the advice of a program advisor to strengthen mathematics and science knowledge, to refine and update pedagogy competence, to broaden general education, to gain knowledge about the nature of information and information materials, to develop and refine skills in integrating technology into instruction, and to ensure that certification standards are satisfied. Professional electives may be taken from the core courses or from any course in the content categories. Any graduate course offered in the University may serve as a professional elective if the student has adequate preparation to take the course and it is deemed appropriate by the program advisor.

Drexel University
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Ph.D. Program

Ph.D. Program
The Ph.D. program in Educational Leadership Development and Learning Technologies prepares visionary leaders who understand the emerging role of technologies in all educational settings and provides a venue for research into effective practices in a variety of learning institutions. This program is designed for students interested in using technology to transform education.

The goals of the program include:

• *Expanding the education of principals and other school leaders to include the latest research-based knowledge and skills about learning, teaching, community involvement, and instructional and organizational leadership for the improvement of schools*

• *Providing a terminal degree for co-operative education leadership, science museum educators, and educational instructional designers that incorporates cutting-edge knowledge delivery systems, including asynchronous and synchronous instruction*

• *Graduating teacher leaders with learning technologies expertise who will prepare excellent K–12 classroom teachers to integrate multimedia and technology into instruction*

• *Preparing college and university professors who understand integrative curricula and constructivism and can convey understanding of the interaction between content knowledge and pedagogy knowledge, especially in mathematics, the sciences, and technology education*

• *Developing a research agenda that addresses technological transformation in education with emphasis on leadership using multimedia, distance learning, and learning technologies*

Program Objectives

• *Design and implement integrative learning experiences for the program's students*

• *Incorporate multimedia technology into the educational experience of the students*

• *Design and implement new instructional paradigms including synchronous and asynchronous instruction and distance learning*

• *Develop research-based learning and instruction frameworks for educational technology leadership, especially in mathematics and the sciences*

Admission Requirements

In addition to the University's general graduate admission requirements, applicants

to the Ph.D. program must also submit three letters of recommendation and current GRE scores.

The program requires mathematics and science content knowledge and computer skills at least equivalent to those required of Drexel elementary education majors. All candidates must possess writing skills equivalent to that of a technical writing course early in their course of study.

Credentials of entering students interested in faculty positions in mathematics or science education at the university level will be assessed to determine what, if any, discipline-based courses will be required.

Course Sequence

Coursework for the Ph.D. program is built on a logical development of experiences and content knowledge for the students. Students begin the program by taking a set of eight core courses with the other members of their cohort:

Courses		Credits
EDUC 800	**Educational Leadership and Change**	3.0
EDUC 801	**Creative Strategies for Educational Leaders**	3.0
EDUC 802	**Using and Integrating Learning Technologies**	3.0
EDUC 803	**Educational Research Design**	3.0
EDUC 804	**Study of Educational Organizations and Programs Through Evaluation and Assessment Design**	3.0
EDUC 810	**Educational Research Design II**	3.0
EDUC 811	**Designing and Developing Multimedia Applications for Learning**	3.0
EDUC 813	**Educational Issues**	3.0

Additional required courses

EDUC 815	**Writing for Research, Publication, and Funding in Education**	3.0
EDUC 818	**Applied Research Study**	3.0
EDUC 998	**Ph.D. Dissertation**	2.0-12.0

Specific courses to complete the program requirements are selected from the following professional electives list with the student's program advisor:

Courses		Credits
EDUC 527	**Understanding Learning Disabilities**	3.0
EDUC 530	**Advanced Techniques in Instruction and Assessment**	3.0
EDUC 531	**Applications of Teaching and Assessment Techniques**	3.0
EDUC 812	**Staff Development and Team Building**	3.0

EDUC 814	**Designing Educational Organizations**	3.0
EDUC 815	**Writing for Research, Publication, and Funding in Education**	3.0
EDUC 816	**Inclusion Issues**	3.0
EDUC 817	**Curriculum Models**	3.0

Drexel University
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The Bennett S. LeBow College of Business

General Information
The graduate programs in business administration at Drexel are professionally based and technologically oriented. The LeBow College of Business offers 15 fields of concentration leading to:

- MBA
- Drexel MBA Online
- Executive MBA
- One Year MBA
- Specialized Master of Science degree programs
- Doctoral programs
- Advanced Professional Certificate

Full- and part-time study is available. Part-time students are usually full-time employees who can attend classes only in the evening. Full-time students may also find it desirable or necessary to attend evening classes to meet their program objectives. By taking four courses a term for four terms, a student can earn an MBA in one calendar year, if foundation courses have already been completed.

The Bennett S. LeBow College of Business is fully accredited by AACSB International—The Association to Advance Collegiate Schools of Business.

Mission
The mission of the LeBow College of Business is to educate students for successful business and professional careers. At the undergraduate and master's levels, this objective is accomplished by providing high-quality educational programs that integrate theory and practice through a combination of academic coursework and complementary professional work experience. Our highly regarded co-operative education program, in which students alternate periods of academic study and full-time off-campus employment with partner companies, sets us apart from other business schools. At the Ph.D. level, our programs provide both a rigorous understanding of the disciplines of business and the research skills that enable exploration and discovery of new knowledge within those disciplines.

The vitality of all our academic programs is maintained by the scholarship of the College's distinguished *faculty*. The College is committed to advancing the science and practice of management through basic, applied, and instructional research in the various disciplines of business.

The College and its faculty maintain strong connections to business professions and the community by participation in professional organizations, a commitment to community service, and a dedication to providing opportunities for lifelong learning.

Admission Requirements
To qualify for admission to any of the graduate programs in the College, a candidate must submit an application, transcripts, recommendations, and Graduate Management Admission Test (GMAT) scores to the Graduate

Admissions Office. Candidates must meet the admissions standards set by the Accreditation Council of the AACSB and the faculty of the College. In general, students entering the graduate programs of the College exceed those standards.

Financial Assistance

A limited number of graduate teaching or research assistantships are available in the full-time MBA, M.S., and Ph.D. programs. Additional information may be secured by writing to the Director of Graduate Programs for the LeBow College of Business.

Alternatively, students might consider experiential education (see Career Integrated Education). Apart from other advantages accruing to students who select the experiential option, the income can help finance a graduate education.

Student Organizations

All graduate students in the College are eligible to join the Graduate Business Association, which coordinates activities for full-time and part-time graduate students in the College. Graduate students are also eligible for an invitation to join Beta Gamma Sigma, the national business honor society, and Alpha Iota Delta, the honor society of the Institute of Decision Sciences. Other student organizations and societies are sponsored by individual departments and areas of concentration.

Foreign Study

Students matriculated in the MBA or M.S. programs may choose to take courses in the MBA in London program. Selected courses are offered at Drexel's London campus in the Queen's Terrace section of London. This program offers a unique international experience incorporating visits to leading businesses in this important European business center. The courses are offered in a two-week format, usually during the scheduled term breaks.

Center for Quality and Productivity

The objective of the center is to support a research group, emphasizing industrial and commercial quality and productivity. Drawing upon the disciplines of statistics, management, behavioral science, operations research, and financial analysis, the center provides an integrated source of applied research services for the industrial community.

To achieve its objective, the center supports a coordinated series of continuing education courses, supports and conducts applied research to meet contemporary quality and productivity problems of regional industrial and commercial institutions, and provides field experience for graduate and undergraduate students.

Master of Business Administration Program

Goals of the MBA Program

Drexel University's innovative, high-quality MBA program is recognized for its excellence and for its preparation of students for successful professional careers. We seek to attract and retain students with excellent undergraduate academic records and a commitment to graduate education, along with a career integrated education (CIE) focus. From its inception, Drexel has been a technology-oriented university, and we are committed to focusing our graduate curricula to reflect the importance and use of technology in both business and not-for-profit organizations.

The MBA program is designed to:

• *Integrate the foundations of business, problem-solving, and decision-making skills; organization theory; and practical aspects of institutional management*

• *Prepare students for managerial positions in business and other institutions*

• *Offer specializations in various areas of management*

• *Capitalize on communication skills, people skills, global perspectives, technological competence, pragmatic emphasis, and ethical perspectives*

• *Offer students the opportunity to participate in the Career Integrated Education option, in which they hold a full-time management position for a six-month period once they have completed about half of their graduate program*

Academic Preparation

All applicants to master's programs in business are expected to hold a four-year baccalaureate degree or its equivalent from an accredited institution. The curriculum assumes that the student has knowledge of calculus. In addition, the curriculum assumes that students have personal access to and working knowledge of personal computers to facilitate their academic work. Please note that introductory microeconomics and introductory macroeconomics courses are prerequisites to all advanced-level courses in economics.

Degree Requirements

The MBA degree requires 67 credits. The first-year courses consist primarily of the common body of knowledge prescribed by the AACSB, which is required of all students receiving degrees in business and administration from colleges accredited by the AACSB. First-year (foundation) courses should be completed before second-year courses are undertaken.

Although foundation courses are required for the MBA or M.S. degree, credits earned for equivalent courses at the undergraduate level can transfer to the program at the discretion of an academic advisor. These credits are not transferable as graduate course credits.

The second year of the MBA program consists of a tools-and-concepts core of five courses; a set of five professional elective courses, one from each of five professional areas; an area of concentration, consisting of three courses and a

seminar; and two courses of business electives, one of which must be outside the student's area of concentration. Students may not take both business electives in the same concentration.

The philosophy of the post-core courses is to allow students the widest latitude, consistent with the objectives of the degree, to design a course of study relevant to professional goals. Accordingly, particular programs of study can be arranged in consultation with the advisor.

A student may complete a second area of concentration within the MBA degree by taking the courses required for that concentration. It is also possible to complete both an M.S. and an MBA by taking 11 courses beyond those required for a single degree.

All students must submit a plan of study no later than the term after they have completed five second-year courses. Timely completion of the plan of study minimizes the risk of violating program requirements, which would result in delay of graduation. All first-year courses must be completed before the plan of study is approved. Plan of study forms are available in the Master's Program in Business Office, Room 105, Matheson Hall.

For further information about master's degree programs in the LeBow College of Business, contact the Director of Graduate Programs in Business, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104; 215-895-1791.

Career Integrated Education
All students enrolled in Drexel University's master's programs in business have the option of participating in the new Drexel Plan for Career Integrated Education (CIE).

Long identified with its undergraduate co-operative education program, Drexel is now committed to providing this experience at the master's in business level. The Drexel Plan for Career Integrated Education is open to all students—full-time, part-time, and international—who have successfully completed a minimum of eight of their required 16 advanced master's-level courses. The employment period is coordinated by University staff and monitored by a member of the Drexel faculty and a manager on the employer's staff. The career experience will match the student's academic and work background. Further, it will be integrated with a seminar the student will take later.

For students choosing this academic option, the program requires:

• *A formal orientation workshop in business protocol, ethics, résumé preparation, interview techniques, and other processes essential to professional positions*

• *A plan of study adopted prior to the career experience that establishes the integration between that experience and the academic coursework*

• *Employment in a position appropriate to the student's career goals, in connection with which a mid-term report will be submitted as an academic course requirement*

• *Submission of a final report to the academic advisor*

The CIE options available to interested master's students are:

• *Enhanced CIE (open to full-time students): Involves full-time employment with an approved employer. Other coursework is deferred during the employment period.*

• Parallel CIE (open to full-time students): Involves at least 24 but no more than 30 hours per week of employment. No more than two classroom courses may be undertaken during the employment period.

• Extended-Day CIE (open to part-time students): Involves 10 hours per week of employment with a current employer, but in a new position (this work is undertaken in addition to regular full-time responsibilities). Coursework is deferred for the two-term duration.

• Cross-Train CIE (open to full- or part-time students): Involves 25 hours per week of employment with a current employer, but in a new position. Coursework is not undertaken simultaneously.

Interested students should notify the Director of Master's Programs in Business as soon as possible so that the enrollment and advising sequence may be started in due time.

Transfer Credit

Credit for any or all of the foundation-level requirements may be granted at the discretion of the graduate advisor. For advanced-level requirements, a maximum of 15 credits (five courses) may be transferred into the program. These credits must be earned at the graduate level. All transfer credits are subject to approval by the student's advisor.

Curriculum

Foundation-level courses		Credits
ACCT 111	**Financial Accounting**	3.0
BLAW 211	**Legal Options in Decision-Making**	3.0
ECON 211	**Microeconomics**	3.0
ECON 212	**Macroeconomics**	3.0
FIN 311	**Financial Management**	3.0
MIS 311	**Management Information Systems**	3.0
MKTG 311	**Introduction to Marketing**	3.0
ORGB 311	**Organizational Theory and Behavior**	3.0
POM 311	**Management of Operations**	3.0
STAT 313	**Quantitative Analysis III**	3.0

Advanced-level courses		
MGMT 602	**Management and Technology**	3.0
MGMT 698	**Special Topics: Business Communication Skills**	3.0
MGMT 780	**Strategic Management**	3.0
STAT 602	**Decision Sciences I**	3.0

STAT 604	**Decision Sciences II***	3.0
Professional electives (one from each of the following groups)**		**15.0**
ACCT 602	**Managerial Accounting**	
ACCT 631	**Advanced Managerial Accounting**	
ACCT 650	**Integrated Accounting Systems**	
ACCT 790	**Tax Policy Seminar**	
ECON 610	**Microeconomics**	
ECON 614	**Macroeconomics**	
ECON 650	**Business and Economic Strategy**	
FIN 620	**Advanced Financial Management**	
FIN 622	**Financial Institutions and Markets**	
FIN 626	**Investment Management**	
FIN 642	**Business Conditions and Forecasting**	
HRMT 622	**Human Resource Administration**	
MIS 630	**Interactive Decision Support Systems**	
ORGB 620	**Individual Behavior in Organizations**	
ORGB 622	**Group and Interpersonal Behavior in Organizations**	
POM 620	**Management of Manufacturing Firms**	
POM 624	**Management of Service Firms**	
MKTG 620	**Marketing Strategy and Planning**	
MKTG 646	**Services Marketing**	
MKTG 650	**Marketing Management in the New Economy: Cases and Problems**	
	Area of concentration***	12.0
	Business electives******	6.0

***Students contemplating the management science concentration should take OPR 620 (Operations Research) instead of STAT 604.**

****With approval of department head or program director, more advanced courses may be substituted for listed courses. Please note that introductory microeconomics and macroeconomics courses are prerequisites for all advanced economics courses.**

*****Four courses are taken as specified in any one of the areas of specialization (see following sections). Some concentrations require 15 credits. The additional credits should be taken from that concentration's professional electives.**

******For an MBA with a single concentration, two electives are selected from the 600- through 800-level business courses. One of these courses must be taken outside the area of concentration. Certain concentrations require that a specific business elective be taken.**

Concentrations

Accounting

ACCT 111 is a prerequisite for all advanced accounting and taxation courses.

Accounting Control

Advisor: Dr. Henry R. Jaenicke

Courses		Credits
ACCT 790	**Seminar in Accounting**	3.0

Three of the following*

ACCT 620	**Asset Valuation and Income Determination**	
ACCT 621	**Liability and Equity Valuation**	
ACCT 622	**Advanced Financial Accounting**	
ACCT 640	**Auditing Theory and Philosophy**	

***Other M.S. accounting courses are available, with permission of the student's advisor**

Taxation

Advisor: Dr. Anthony Curatola

Courses		Credits
TAX 790	**Tax Policy Seminar**	3.0
	Graduate tax electives	12.0

Business Electives

Students are encouraged to take 6 credits of business courses (accounting courses are acceptable) that will benefit their career goals.

Decision Sciences

STAT 313 is a prerequisite for all advanced quantitative methods courses.

Advisor: Dr. Jonathan Burton

Students selecting this concentration may focus in operations management, operations research, or statistics. Students may also select courses from among these areas. STAT 602 and STAT 604 should be taken before any concentration courses.

Required course		Credits
STAT 790	**Seminar in Decision Sciences**	3.0

Four of the following courses		**12.0**
OPR 622	**Operations Research II**	
OPR 626	**System Simulation**	
POM 620	**Management of Manufacturing Firms**	
POM 624	**Management of Service Firms**	
STAT 626	**Statistical Sampling**	

STAT 628	**Regression and Correlation Analysis**
STAT 636	**Experimental Design**
STAT 638	**Advanced Quality Control**
STAT 924	**Multivariate Analysis**

Economics
ECON 201 or 211 and ECON 202 or 212 are prerequisites for all advanced economics courses.

Business Economics
Advisor: Dr. Vibhas Madan

Courses		Credits
ECON 610	**Microeconomics**	3.0
ECON 614	**Macroeconomics**	3.0
ECON 616	**Public Finance and Cost-Benefit Analysis**	3.0
ECON 790	**Seminar in Managerial Economics**	3.0

International Business
Advisors: Dr. Trina Larsen Andras, Dr. Vibhas Madan

Courses		Credits
ECON 630	**International Economics**	3.0
FIN 648	**International Financial Management**	3.0
or		
MKTG 630	**International Marketing**	3.0
INTB 620	**International Business Marketing**	3.0
INTB 790	**Seminar in International Business**	3.0

Finance
FIN 311 is a prerequisite for all advanced finance courses. Courses taken as professional electives do not count toward field of concentration requirements.~

Financial Management
Advisor: Dr. Edward Nelling

Courses		Credits
FIN 620	**Advanced Financial Management**	3.0
FIN 624	**Risk Management**	3.0
FIN 628	**Capital Budgeting**	3.0
FIN 790	**Seminar is Financial Management**	3.0

Investment Management
Advisor: Dr. Eric Higgins

Courses		Credits
FIN 622	**Financial Institutions and Markets**	3.0
FIN 624	**Risk Management**	3.0
FIN 626	**Investment Management**	3.0
FIN 794	**Seminar in Investments**	
or		
FIN 790	**Seminar in Financial Management**	3.0

Management

The general pattern of requirements for this concentration is indicated below. The courses listed are those most often selected by students; however, a specific plan of study is created for each student.

Organization and Human Resource Management

Advisors: Dr. Jeffrey Greenhaus, Dr. Saroj Parasuraman, Dr. Sidney R. Siegel, Dr. Joan Weiner

Courses		Credits
HRMT 622	**Human Resource Administration**	3.0
ORGB 622	**Group and Interpersonal Behavior in Organizations**	3.0
ORGB 790	**Seminar in Organization and Human Resource Management**	3.0

Two of the following courses		6.0
HRMT 620	**Appraisal and Compensation of Human Resources**	
HRMT 626	**Human Resource Planning and Development**	
HRMT 630	**Organizational Staffing**	
HRMT 636	**Collective Bargaining**	
MGMT 680	**Executive Leadership: Substance and Style**	
ORGB 620	**Individual Behavior in Organizations**	
ORGB 632	**Organizational Change and Development**	

Recommended business electives		Credits
MGMT 670	**Business Ethics**	3.0
MGMT 698	**Special Topics: Career Management**	3.0
MGMT 698	**Special Topics: Project Management**	3.0

Management Information Systems

Advisors: Dr. Bay Arinze, Dr. Dongjun Wu

MIS 311 is a prerequisite for all advanced MIS courses. MIS 624 (Systems Analysis and Design) should be taken at the start of the concentration.

Courses		Credits
MIS 624	**Systems Analysis and Design***	3.0
MIS 790	**Seminar Project in MIS**	3.0

Three of the following courses		9.0
MIS 620	**Telecommunications Management**	
MIS 628	**Microcomputers for Management**	

MIS 630	**Interactive Decision Support Systems**
MIS 632	**Database Analysis and Design for Business**
MIS 636	**Decision Processes in MIS**
MIS 640	**Software Packages for Management**
MIS 641	**MIS Policy and Strategy**

***This course may be waived based on the student's relevant industry experience and/or similar coursework. See one of the MIS advisors for more information.**

Marketing

MKTG 311 is a prerequisite for all advanced marketing courses.

Marketing Management

Advisor: Dr. Rolph Anderson

Courses		Credits
MKTG 652	**Marketing Information: Management and Research**	3.0
MKTG 790	**Seminar in Marketing**	3.0

Two of the following courses		6.0
MKTG 620	**Marketing Strategy and Planning**	
MKTG 622	**Buyer Behavior**	
MKTG 624	**Channels of Distribution Management**	
MKTG 628	**Transportation and Logistics**	
MKTG 630	**International Marketing**	
MKTG 632	**Sales Management Seminar**	
MKTG 634	**Marketing Communications Management**	
MKTG 636	**Business-to-Business Marketing**	
MKTG 638	**New Product Planning, Strategy, and Development**	
MKTG 642	**Multivariate Data Analysis for Managers**	
MKTG 646	**Services Marketing**	
MKTG 650	**Marketing Management in the New Economy: Cases and Problems**	

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Drexel MBA Online

General Information

Drexel University's MBA Online provides a technology-management-focused MBA program over the Internet. Our mission is to serve the needs of graduate students whose schedule or location prevents them from otherwise participating in a high-quality MBA program.

The entire foundation level is available online. Several of the MBA foundation courses and advanced-level courses are available as part of our "open? MBA program. Consult the course catalog on the MBA Online site for detailed information about each term. The open structure allows students to take courses according to their own schedule, and students preparing for the Techno MBA who need foundation courses can start in any quarter.

Students wishing to pursue the entire MBA degree online may apply for the Techno MBA. This online track is intended for professionals who wish to prepare to manage technologically demanding enterprises. Cohorts begin in the fall and spring terms. There is a residency component at the advanced level in the beginning, middle, and end of the program. The final residency is at Drexel's campus in London. The online track does not have a field of concentration option but offers a curriculum with a technology management focus.

MBA Online is fully a part of the graduate program in the LeBow College of Business, with the same admission standards, faculty, and degree program. For complete information, visit the MBA Online program's website.

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Executive MBA Program

Objective

The Executive MBA is designed for working professionals with a minimum of five years of managerial experience. The program stresses strategic thinking, working effectively in a team environment, and leadership. Analytical and problem-solving skills are interwoven through the coursework. There is a strong emphasis on the international aspects of doing business in the 21st century.

Degree Requirements

Students in the Executive MBA (EMBA) program are required to complete 68 credits. They proceed through the program in a cohort of 20 to 30 students from diverse backgrounds. Students earn an MBA in business administration without an area of specialty. In addition to a Business Foundation simulation, which integrates the functional areas of business, students complete advanced courses in accounting, economics, finance, marketing, and management. Course substitutions may be made only with the approval of the program director. There are no waivers of foundation courses, and transfer credits are not accepted.

There are three EMBA formats: Weekend, Global, and Evening.

Classes in the Weekend EMBA program meet one day per week on alternate Fridays and Saturdays from 8 a.m. to 5 p.m. A 10-day international trip is included to enable students to observe overseas business practices firsthand.

Classes in the Evening EMBA program meet twice a week, on Monday and Thursday evenings, starting each June. Students take two classes per quarter over 24 months and attend classes on six Saturdays during the two-year period of study. As with the Weekend EMBA, the program includes a 10-day international trip.

Ten of the Global EMBA program's courses are conducted via the Internet. The remaining 10 courses are completed during five intensive six-day sessions at different locations (three sites in the United States and two abroad). The curriculum is the same as in the other two formats, but the Global EMBA places greater emphasis on conducting business internationally and on leading high-performance mobile teams.

Textbooks, course registration service, and meals on class days are included in the tuition.

Admission

The EMBA program has its own admission procedures. A personal interview is required. Students admitted to the program have, on average, 14 years of work experience and significant potential for advancement in their organizations. For further information, please contact:

Center for Executive Education, LeBow College of Business; Drexel University; 32nd and Market Streets; Philadelphia, PA 19104; 215-895-1604; emba@drexel.edu

Students must be admitted to the Executive MBA program to register for EMBA-

cohorted classes.

Curriculum

Courses		Credits
ACCT 602	**Managerial Accounting**	3.0
ACCT 611	**Financial Reporting and Analysis**	4.0
BLAW 698	**Special Topics: Legal Options in Decision Making**	4.0
BUSN 611	**Business Foundations and Performance**	4.0
ECON 611	**Managerial Economics for Business**	4.0
FIN 611	**Financial Strategies**	4.0
FIN 620	**Advanced Financial Management**	3.0
INTB 620	**International Business Management**	3.0
INTB 621	**Advanced International Seminar**	3.0
MGMT 602	**Management and Technology**	3.0
MGMT 680	**Executive Leadership: Substance and Style**	3.0
MGMT 698	**Special Topics: Business Communications**	3.0
MGMT 780	**Strategic Management**	3.0
MIS 311	**Management Information Systems**	3.0
MKTG 698	**Special Topics: Marketing Management**	4.0
ORGB 611	**Leading High-Performance Organizations**	4.0
POM 311	**Management of Operations**	3.0
STAT 604	**Decision Sciences II**	3.0
STAT 611	**Quantitative Decision-Making**	4.0
	Elective	3.0

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One Year MBA Program

The One-Year MBA is designed for business students who want to accelerate their academic experience without compromising quality. The comprehensive education focuses on strategic management and leadership, managerial finance, international business, entrepreneurship, and leadership.

The program begins in June with a full 11-week term overview of the business foundations. This term is designed to sharpen and refresh skills and business knowledge while preparing students for the upcoming terms' intensive course load. All students participate in a minimum of four courses; the number and selection of courses, however, are based on an analysis of individual students' academic backgrounds.

In September, students begin the advanced curriculum with their cohort, with whom they will study for the remaining three terms. Students start with the Inter-term, an introduction to upcoming courses and a weeklong business simulation. In each of the successive terms, the courses are delivered via a combination of real-time and online classes, coupled with business visits to complement the program structure and enrich the learning atmosphere.

Each term includes a number of mini-modules, or short seminars designed to cover new and interesting topics in today's business world. Students are required to attend at least three of these modules to enhance the overall experience.

In the final term, students participate in a seminar held in an international location to gain invaluable global business experience. On the 10- to 12-day trip, students take part in classroom discussions, hear guest lecturers, and visit business and cultural sites.

Master of Science Programs

The college offers M.S. programs in accounting, finance, and taxation. The M.S. degree requires 78 credits. Generally speaking, it is a two-year course of study, the first year consisting primarily of the common body of knowledge prescribed by AACSB International—The Association to Advance Collegiate Schools of Business, and the second year consisting of core and specialization courses and related electives. All programs are arranged to accommodate both full- and part-time students.

The first-year courses are listed under the MBA program. Individual program requirements and curricula are outlined in the following sections. Students are strongly encouraged to discuss their plan of study with their department head and must submit a plan of study to the program director within their first two terms.

Accounting

Objectives

The M.S. program in accounting is designed to meet the needs of those who plan careers in public accounting, corporate accounting, not-for-profit accounting, or government accounting.

The entire program is offered in the evening and Saturdays. The program can be completed in the evening in two years by taking two courses per term, including summers, once first-year courses are completed.

Requirements

Accounting students must have a strong background in intermediate accounting and managerial accounting. The number of prerequisite courses required depends on the student's previous academic record, but all prerequisites must be completed before proceeding to courses at the 600 through 800 level. In addition to the first-year business courses, each M.S. candidate must complete 48 graduate credits in accounting and related business disciplines.

Curriculum

For first-year courses, see the *MBA program*.

Courses		Credits
ACCT 622	**Advanced Financial Accounting**	3.0
ACCT 623	**Financial Accounting Theory**	3.0
ACCT 631	**Advanced Managerial Accounting**	3.0
ACCT 640	**Auditing Theory and Philosophy**	3.0
ACCT 650	**Accounting Information Systems**	3.0
ACCT 790	**Seminar in Accounting**	3.0
TAX 620	**Individual Taxation**	3.0
TAX 630	**Corporate Taxation**	3.0

Required non-accounting courses

ECON 610	**Microeconomics**	3.0
FIN 620	**Advanced Financial Management**	3.0
MGMT 780	**Business Policy**	3.0
STAT 602	**Decision Sciences I**	3.0
	Electives*	12.0

***At least two accounting electives must be selected; accounting courses that may be taken as electives include ACCT 636 (International Accounting and Financial Statement Analysis) and ACCT 651 (Not-for-Profit Accounting). The other two electives may be any LeBow College of Business courses, including tax courses, approved by the program director.**

Finance

Objectives

The M.S. program in finance is designed to meet the needs of individuals who plan specialized careers in finance or financial consulting in business or industrial firms, investment management and advisory firms, consulting firms, public accounting firms, or banking and financial institutions. The program is offered on either a full-time or a part-time basis. Part-time courses are available in the evening. The program can be completed in two years by taking two courses per term, including summers, after the first-year courses are completed.

Requirements

In addition to the prerequisite first-year courses, each student must complete 48 credits as described below. The number of prerequisite courses required depends on the student's previous academic record, but all prerequisites must be completed before proceeding to courses at the 600 through 800 level.

Curriculum

For first-year courses, see the *MBA program*.

Core program*		**Credits**
MGMT 602	**Management and Technology**	3.0
MGMT 780	**Business Policy**	3.0
STAT 602	**Decision Sciences I**	3.0
STAT 604	**Decision Sciences II**	3.0

Required finance courses		
FIN 620	**Advanced Financial Management**	3.0
FIN 622	**Financial Institutions and Markets**	3.0
FIN 624	**Risk Management**	3.0
FIN 628	**Capital Budgeting**	3.0
FIN 642	**Business Conditions and Forecasting**	3.0
FIN 790	**Seminar in Financial Management**	
or		
FIN 794	**Seminar in Investments**	3.0

Electives (six of the following courses)**		**18.0**
ACCT 620	**Asset Valuation and Income Determination**	
ACCT 621	**Liability and Equity Valuation**	
ECON 610	**Microeconomics**	
ECON 614	**Macroeconomics**	

ECON 630	**International Economics**
ECON 650	**Game Theory**
FIN 626	**Investment Management**
FIN 631	**Bank Management I**
FIN 632	**Bank Management II**
FIN 640	**Mergers and Acquisitions**
FIN 648	**International Financial Management**
FIN 698	**Special Topics**
MIS 628	**Microcomputers for Management**
MIS 630	**Interactive Decision Support Systems**
OPR 626	**System Simulation**
POM 620	**Management of Manufacturing Firms**
POM 624	**Management of Service Firms**
STAT 622	**Statistical Decision Theory I**
STAT 628	**Regression and Correlation Analysis**
TAX 630	**Corporate Taxation**
TAX 660 **or** TAX 620	**Tax Basis for Decision-Making** **Individual Taxation**

***Upon consultation with the program director, students may substitute more advanced courses for those listed in the core.**

****Additional specialization can be achieved by concentrating the six electives in one of the following fields: banking, investments, or systems management. Also, FIN 698 (Special Topics: Comparative Financial Analysis or Special Topics: Derivatives) may be taken.**

Taxation
Objectives

The M.S. program in taxation is designed to meet the needs of those planning careers as tax professionals in public accounting, private industry, and government. The program is tailored to accommodate both full-time and part-time students. Classes are given only in the evening and on Saturdays. Full-time students have the option of participating in a co-operative educational experience that will integrate traditional in-class instruction and a period of off-campus employment under the supervision of practicing tax professionals. For specific information, request a copy of the MST brochure from the LeBow College of Business, Graduate Office, 105 Matheson Hall.

Requirements

After satisfaction of the first-year prerequisites, the M.S. candidate must complete 48 credits. A variety of substitutions may be made for the required courses, and non-tax courses may be taken as elective courses only with prior written approval of the program director. Substitutes must be selected from advanced courses offered by the LeBow College of Business to meet the minimum 48 graduate credits required for the degree.

Curriculum

For first-year courses, see the *MBA program*.

Courses		Credits
TAX 611	**Tax Research**	3.0
TAX 615	**Tax Practice and Procedure***	3.0

TAX 620	**Individual Taxation****	3.0
TAX 630	**Corporate Taxation****	3.0
TAX 640	**Partnership Taxation***	3.0
TAX 650	**Estate and Gift Taxation**	3.0
TAX 790	**Tax Policy Seminar**	3.0

Non-tax electives **9.0**

Tax electives (selected from the following courses) **12.0**

ACCT 698	**Special Topics*****
TAX 622	**Advanced Property Transactions**
TAX 631	**Advanced Corporate Taxation**
TAX 651	**Estate Planning********
TAX 652	**Fiduciary Income Taxation**
TAX 722	**Tax Accounting**
TAX 731	**Taxation of S Corporations**
TAX 771	**State and Local Taxation**
TAX 780	**Tax Fraud and White-Collar Crime**

Note: TAX 660 (Tax Basis for Decision-Making) is not an approved elective for students enrolled in the taxation program.

***Required in the corporate tax track.**

****An elective tax course may be substituted for either or both of these courses if the material was previously taken at the undergraduate level or acquired from prior tax experiences.**

*****A variety of courses is offered under ACCT 698 (Special Topics), generally in the winter and spring quarters. They could include, for example, Taxation of Retirement Income********, Taxation of Individual Retirement Accounts, or International Tax.**

********** Required in the financial planning track.**

Doctoral Program

The Ph.D. program in the LeBow College of Business is designed to prepare candidates for research and teaching careers, as well as for high-level decision-making positions that require the application of research and theory to the solution of problems in business, government, and not-for-profit settings.

The College offers doctoral programs of study in the following primary specialization areas: accounting, decision sciences (MIS, operations management), economics, finance, marketing, organizational sciences, and strategic management. Secondary specializations are offered in accounting, decision sciences, economics, finance, international business, marketing, organizational sciences, statistics, and strategic management.

The Ph.D. curriculum is composed of 57 credits beyond the master's degree. All doctoral students pursue a common core of courses that provides a solid foundation for subsequent specialization. The Ph.D. core consists of 21 credits distributed as follows: quantitative methods (9 credits), conceptual foundations of business and administration (6 credits), and research design and methodology (6 credits). Upon successful completion of the core examination, students pursue coursework in their primary specialization area (21-credit minimum) as well as their secondary specialization, and then sit for the candidacy examination. Admission to candidacy enables the student to undertake work on the dissertation (6-credit minimum), a piece of original research designed to make a contribution to the student's chosen discipline.

Extensive information regarding Drexel's Ph.D. Program in Business is provided on the program's website. The website describes the primary and secondary specialization areas in depth and provides information on application procedures, credit requirements, time limitations, financial aid, and University facilities. For further information about the Ph.D. program, contact:

Dr. Jeff Greenhaus, Director
Doctoral Programs in Business
LeBow College of Business
Drexel University
3141 Chestnut Street
Philadelphia, PA 19104
215-895-2139
greenhaus@drexel.edu

Please note that Ph.D. students are accepted only for the fall term in odd-numbered years (e.g., 2001–2002, 2003–2004). The application deadline for fall admissions is February 1.

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Advanced Professional Certificate Program

The Advanced Professional Certificate program is available only to applicants who have earned a master's or doctoral degree. The program permits qualified candidates to update their skills in a field of specialization in which they have had previous academic experience or to acquire competence in a new business discipline.

The program does not lead to a degree, and the credits earned in the program are not applicable to any current or future degree program offered by the College of Business and Administration or by Drexel University. The certificate is awarded through the Dean's Office of the College of Business and Administration.

The program normally requires a minimum of 18 advanced (second-year) graduate credits. These must include a minimum set of three courses and a seminar in one of the areas of specialization described above (students planning to study in the area of taxation are advised to take six tax courses, excluding TAX 660). Students must observe any stipulated prerequisites to courses they wish to take and must file a plan of study immediately after admission. Applicants are admitted upon the approval of the Director of Master's Programs in Business.

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The College of Engineering

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

- Chemical Engineering
- Civil Engineering
- Computer Sciences
- Electrical and Computer Engineering (includes Telecommunications Engineering)
- Engineering Geology
- Environmental Engineering
- Master of Engineering
- Materials Engineering
- Mechanical Engineering and Mechanics

In addition, the College offers a multidisciplinary program in Software Engineering in concert with the College of Information Science and Technology and the College of Arts and Sciences.

Chemical Engineering

General Information
The graduate program in chemical engineering 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.

Two major areas of specialization are available: chemical engineering and biochemical 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.

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 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. Students currently enrolled are referred to the departmental Graduate Manual.

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.
Areas of Research Interest
Chemical Engineering

Materials Processing: Polymer processing, melt refining via filtration, reactive-gas atomization, composite materials processing, degassing processes.

Mathematical Modeling: Mathematical modeling and simulation of chemical, biochemical, and biomedical processes.

Process Control: Nonlinear control, optimal control, and adaptive control.

Safety Engineering: Safety and reliability analysis of process systems.

Semiconductor Processing: Thin-film deposition aided by chemical reaction and ion enhancement, gas phase chemical etching, photoresist development and processing, scale-up in semiconductor fabrications.

Transport Phenomena: Fluid mechanics of multiphase flow systems, extensional-flow rheology, high-temperature gas desorption rates, adsorption and desorption, transport in gel phase.

Biochemical Engineering

Biosensors: Sensors for cell density, substrates, and products, and dissolved oxygen using semiconductor fabrication technology; measuring principles including electrochemical, enzymatic, optic, pyroelectric, and acoustic.

Cell Culture Technology: Cultivation of cells under controlled metabolic state, controlled intracellular reduction state and energy-sufficient state, shear-robustness of cells and modification of plasma membrane fluidity and cytoskeleton content of cells.

Cell Microencapsulation: Co-encapsulation of bacteria with oxygen carriers to mimic, in vitro, the in vivo symbiotic relationship of nitrogen-fixing bacteria and leguminous plants.

Controlled Drug Delivery: Development of pulsed and triggered release devices for delivery of bioactive molecules, such as insulin and vaccines.

Immobilized Cells: Cell entrapment in porous beads, cell attachment kinetics, nutrient and environmental control, characterization of immediate environment of immobilized cells, and metabolic behavior of immobilized cells.

Metabolic Sensing: Whole cell culture fluorescence spectroscopy, in situ measurement of NADH, intracellular pH and oxy free radicals in cells and tissues.

Tissue Engineering: Drug delivery, biomaterials (biodegradable polymers, ceramics, and polymer blends), nanotechnology for tissue engineering and drug delivery, gene therapy.

Ultrasound Contrast Agents: Development and testing of injectable biodegradable microcapsules to enhance echogenicity for use in diagnostic ultrasound in patients.

Master of Science Program (Chemical Engineering)
In general, each program leading to the Master of Science in Chemical Engineering must meet the following requirements: chemical engineering, 24 credits; area of concentration, 15 credits; electives, 6 credits.

A thesis of at least 9 credits is required of all full-time candidates. (For full-time students, the 24 credits in chemical engineering courses include the 9 thesis credits

and 15 credits in the core course group described below.) 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.

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. Programs are developed on an individual basis.

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

Curriculum

Courses		Credits
	Five of the following	15.0
CHE 502	**Mathematical Methods in Chemical Engineering**	
CHE 513	**Chemical Engineering Thermodynamics**	
CHE 525	**Transport Phenomena I**	
CHE 543	**Kinetics and Catalysis I**	
CHE 554	**Process Systems Engineering**	
CHE 658	**Advanced Process Design**	
	Area of concentration	15.0
	Thesis	9.0

	Electives	6.0

Areas of Concentration

Biochemical Engineering

Courses		Credits
BIO 500	**Biochemistry I**	3.0
BIO 501	**Biochemistry I Laboratory**	2.0
BIO 610	**Biochemistry II**	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

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
ENVR 501	**Chemistry of the Environment**	3.0
ENVR 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

ENVR 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

Master of Science Program (Biochemical Engineering)

In general, each program leading to the Master of Science degree with specialization in biochemical engineering must meet the following requirements: biochemical engineering, 18 credits; biological sciences, 12 credits; electives, 15 credits.

A thesis of at least 9 credits is required for all full-time students. (The 18 credits in biochemical engineering courses include 9 thesis credits and 9 credits in core courses.) The thesis subject may be either a fundamental or an applied problem of limited scope in the general area of biochemical engineering.

Electives may be chosen broadly from graduate course offerings with prior approval of the graduate advisor.

Curriculum

Required biochemical engineering courses		Credits
CHE 560	**Transport Phenomena in Biological Systems**	3.0
CHE 562	**Bioreactor Engineering**	3.0
CHE 564	**Unit Operations in Bioprocess Systems**	3.0

Required biological sciences courses

BIO 500	**Biochemistry I**	3.0
BIO 520	**Cell Physiology**	3.0
BIO 610	**Biochemistry II**	3.0
	Thesis	9.0
	Electives	18.0

Suggested electives include:

Biomedical Engineering

Courses		Credits
BMES 521	**Principles of Bioengineering and Instrumentation I**	3.0
BMES 522	**Principles of Bioengineering and Instrumentation II**	3.0
BMES 523	**Principles of Bioengineering and Instrumentation III**	3.0

BMES 681	**Physics of Living Systems I**	3.0
BMES 682	**Physics of Living Systems II**	3.0
BMES 683	**Physics of Living Systems III**	3.0

Bioscience and Biotechnology

Courses		Credits
BIO 530	**Techniques in Microbial Genetics**	3.0
BIO 615	**Experimental Biochemistry I**	3.0
BIO 618	**Experimental Biochemistry II**	3.0
BIO 620	**Biomembranes**	3.0
BIO 635	**Topics in Eucaryotic Genetics**	3.0
BIO 660	**Microbial Physiology**	3.0

Doctoral Program

Superior students with M.S. or B.S. degrees will be considered for the doctoral program in chemical engineering or biochemical engineering.

All students are expected to develop competence in their areas of specialization. All students are urged to select a thesis topic and supervisor early in the program. A student becomes a Ph.D. candidate upon passing the candidacy examination, which includes writing and defending a research proposal; a doctoral committee is formed to direct his or her research and other aspects of the program of study.

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.

Faculty Research Interests

Richard A. Cairncross, Ph.D. *(University of Minnesota), Assistant Professor*
Materials processing, drying fundamentals, mathematical modeling.

Donald R. Coughanowr, Ph.D. *(University of Illinois), Professor Emeritus*
Process dynamics and control, diffusion and chemical reaction in drops, environmental engineering.

Nily Dan, Ph.D. *(University of Minnesota), Assistant Professor*
Design of synthetic gene and drug carriers, control of the performance of trans-membrane proteins, stabilization of polymer-colloid suspensions.

E. D. Grossmann, Ph.D. *(University of Pennsylvania), Professor*
Thermodynamics of mixtures, process analysis-energy conversion, process safety and reliability analysis, process design, fluid mechanics of accelerated flows, environmental process engineering.

Dhirendra S. Katti, Ph.D. *(University of Bombay), Research Assistant Professor*
Controlled drug delivery systems, tissue engineering, nanotechnology, biomaterials.

Cato T. Laurencin, Ph.D. *(Massachusetts Institute of Technology), M.D. (Harvard*

University), Helen I. Moorehead Distinguished Professor
Biomaterials, tissue engineering, controlled drug delivery, new polymer synthesis.

Young H. Lee, Ph.D. *(Purdue University), Professor*
Semiconductor and microelectronic materials processing, plasma and photon enhanced chemical vapor deposition, plasma reactor design, oxygen transfer in bioprocesses, sensors for bioprocess monitoring.

Anthony M. Lowman, Ph.D. *(Purdue University), Associate Professor*
Polymer materials, biomedical applications of polymers, polymer characterization.

Raj Mutharasan, Ph.D. *(Drexel University), Frank A. Fletcher Professor*
Cell culture technology, microbioreactors, biosensing using photonics and microcantilevers, modeling metabolic reaction network, process metallurgy.

Giuseppe R. Palmese, Ph.D. *(University of Delaware), Associate Professor*
Thermosetting materials, dendritic polymers, interface science, composites, nano-structured materials, reaction engineering.

Masoud Soroush, Ph.D. *(University of Michigan), Associate Professor*
Process dynamics and control, development of nonlinear control algorithms, process design, polymerization reactor control, state and parameter estimation, polymerization reaction engineering, fault detection and identification.

Charles B. Weinberger, Ph.D. *(University of Michigan), Professor and Department Head*
Polymer processing, fluid mechanics of multiphase systems, extensional-flow rheology, pneumatic transport of particles.

Margaret A. Wheatley, Ph.D. *(University of Toronto), Professor, Biomedical Engineering, Science, and Health Systems*
Controlled release technology (bioactive compounds), ultrasound contrast agent development, in vitro nitrogen fixation using bacteria microencapsulated in synthetic nodules.

Steven P. Wrenn, Ph.D. *(University of Delaware), Assistant Professor*
Biological colloids (vesicles, micelles, lipoproteins), cholesterol nucleation, gallstone disease, heart disease (atherosclerosis), lipid phase behavior, microstructure analysis, fluorescence methodologies.

Facilities

Animal Cell Bioreactor Laboratory
This laboratory contains a laminar flow hood, CO incubator, two-liter isolated low-shear bioreactor, one-liter column packed-bed bioreactor, and microscopes.

Biochemical Analytical Instruments
This laboratory contains a Sorval centrifuge, low-speed centrifuges, automated gas chromatographs with FID and TCD, automated HPLC with gradient capability and UV-VIS variable-wavelength and refractive index detectors, fluorescence spectrophotometer, and UV-VIS scanning absorbance spectrophotometer.

Biomedical Engineering Laboratory
This laboratory contains an apparatus for ionotropic gelation/microencapsulation, UV-VIS spectrophotometer, probe and bath sonicators, computer-linked scintillation counters, and state-of-the-art ultrasound equipment. Projects include joint research with Thomas Jefferson University Hospital Department of Ultrasound.

Center for Advanced Biomaterials and Tissue Engineering
The center consists of (1) Polymer Synthesis Laboratory equipped with a nitrogen glove box, high- and low-temperature ovens, rotovaporators and a chemical hood; (2) Matrix Fabrication Laboratory equipped with a Sorval Ultracentrifuge and a lyophilizer; (3) Cell Culture Laboratory equipped with PCR facilities; a sterile laminar flow hood; -20° C, -70° C, and -150° C freezers; refrigerators; laptop and micro centrifuges; CO2 incubators; and a Zeiss microscope equipped with camera and video imaging/analysis system (Bioquant Histology software); (4) Instrumentation Laboratory consisting of a porosimeter, HPLC, GPC, Instron-5500 mechanical testing system, UV-VIS spectrophotometer, compression molding machine, and a goniometer.

Chemical Reactor Engineering Laboratory
This laboratory contains batch and continuous flow reactors, high-pressure Parr reactor with injection system, analytical facilities with various gas and liquid chromatographs, and Perkin Elmer FTIR system.

Chemical Sensor Laboratory
This laboratory contains facilities for biosensor fabrication, including stereo-microscope, micromanipulator, pipette pullers, sputter coaters, electrometers, picoammeters, real-time computer data acquisition systems, spectrum analyzer, and spectrophotometers.

Control Laboratory
This laboratory contains electronic, pneumatic, and microprocessor-based controllers; microcomputers; workstation computers; measuring elements for temperature, pressure, flow, pH, and composition; and simulation software packages.

Fermentation Laboratory
This laboratory contains a seven-liter Chemap fermentor, 14-liter NBS instrumented fermentor, and several one- and two-liter Virtis chemostats.

Multiphase Flow Laboratory
This laboratory contains couette viscometers, laser-doppler-anemometers, particle feeders and counters, and measuring devices for void-fraction and bubble size and flow.

Polymer Processing Laboratory
This laboratory contains a laboratory-scale screw extruder, melt flow dies, pressure monitoring devices, continuous take-up machines, compression molding devices, and polymer melt mixing apparatus.

Semiconductor Processing Laboratory
This laboratory contains a scanning electron microscope, mass spectrometer, optical emission spectroscope, photolithography equipment, plasma vacuum deposition system, dry etching system, chemical vapor deposition reactors, diffusion furnace, thin-film thickness monitoring system, and laminar hoods for handling semiconductor wafers.

Drexel University
Catalog 2002 2003

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 Ph.D. program is to develop the abilities to discover, pursue, and apply basic knowledge. Ph.D. 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.

Master of Science Program

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. Related M.S. programs are available in engineering geology and geosynthetic engineering for qualified students. Admission and prerequisites are determined on the basis of a student's undergraduate transcript.

Most M.S.C.E. 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 30 credits must be in the major field of interest. 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/geoenvironmental*
- *Water resources/coastal*
- *Building systems/energy*
- *Geosynthetics*
- *Infrastructure materials*

Dual graduate degrees are possible. Among the more popular programs are combining the M.S. in Civil Engineering with an M.S. in Engineering Geology, 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
The Ph.D. degree is awarded for original research on a significant civil engineering problem. Graduate students who have completed their M.S. degrees work closely with individual faculty members (see Faculty Research Interests below). Ph.D. dissertation research is usually supported by a research grant from a government agency or an industrial contract.

Doctoral students normally take at least 45 credits, including research credits, beyond the master's degree requirements. Full-time residency for one continuous academic year is required for the Ph.D. 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 Engineering Department is required of all Ph.D. applicants.

After approximately one year of study beyond the master's degree, doctoral students take a candidacy examination, consisting of written and oral parts; successful completion of this examination is required to become a Ph.D. candidate. Each Ph.D. candidate is supervised by a major professor and a doctoral committee chaired by the major professor.

Ph.D. candidates submit a detailed proposal for dissertation research to the doctoral committee. 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.

Ph.D. graduates find positions in

- *Universities*
- *Consulting engineering*
- *Industrial or government research*
- *Public operating agencies*

Faculty Research Interests
Emin Aktan, Ph.D. *(University of Illinois at Urbana-Champaign), Professor*
Modeling and monitoring of large-scale transportation infrastructure; performance, deterioration, and inference of structural performance.

Shi-Chieh Cheng, Ph.D. *(West Virginia University), Associate Professor*
Geotechnical engineering, probabilistic analysis and risk assessment, experimental soil mechanics, slope stability, retaining structures, geosynthetics.

Edward L. Doheny, Ph.D. *(Indiana University), Professor*
Engineering geology, clay mineralogy, engineering geophysics, groundwater hydrology.

Mohamed Elgaaly, Sc.D. *(University of Michigan), Professor*
Seismic analysis and behavior, structures, dynamics of structures, nonlinear finite element analysis and numerical methods, behavior of steel plate structures, design of steel buildings and bridges.

Patricia M. Gallagher, Ph. D. *(Virginia Polytechnic Institute)*
Soil behavior, ground modification, geoenvironmental engineering, groundwater control.

Ahmad Hamid, Ph.D. *(McMaster University), Professor*
Analysis and design of reinforced concrete, prestressed concrete, and masonry structures.

Harry G. Harris, Ph.D. *(Cornell University), Professor*
Structural models, dynamics of structures, plates and shells, industrialized building construction.

Yick Grace Hsuan, Ph.D. *(Imperial College, University of London), Associate Professor*
Polymeric materials in civil and geotechnical engineering, polymer test methods development, stress cracking and hydrolysis of polyethylene geomembranes, polyethylene telephate (PET) geotextile.

Robert M. Koerner, Ph.D. *(Duke University), Harry L. Bowman Professor of Civil Engineering*
Geotechnical engineering, nondestructive testing, geotextiles, hazardous-waste control.

Joseph P. Martin, Ph.D. *(Colorado State University), Associate Professor and Department Head*
Geotechnical engineering, geoenvironmental, utility infrastructure, ecological impacts of infrastructure and mining.

James E. Mitchell, M.S. *(Harvard University)*, M.Arch. *(University of Pennsylvania), Associate Professor*
Building systems integration and web-based instruction.

Joseph Mullin, Ph.D. *(Pennsylvania State University)*
Project management, mechanics, economic analysis of infrastructure.

Michael Piasecki, Ph.D. *(University of Michigan), Assistant Professor*
Water quality and hydrodynamic modeling.

Wesley O. Pipes, Ph.D. *(Northwestern University), Professor Emeritus*
Microbiology of water distribution systems, biological wastewater treatment, sludge treatment and disposal.

John Popovics, Ph.D. *(Pennsylvania State University), Assistant Professor*
Nondestructive evaluation, fracture mechanics.

Sandor Popovics, Ph.D. *(Purdue University), Professor Emeritus*
Construction materials, composites, silicate chemistry.

T. Agami Reddy, Ph.D. *(Texas A&M), Associate Professor*
HVAC modeling, simulation and analysis of building energy, energy conservation, inverse modeling, data analysis.

Joseph Wartman, Ph.D. *(University of California at Berkeley)*
Soil mechanics and foundations, seismic behavior of earth structures, engineering reuse of waste materials.

J. Richard Weggel, Ph.D. *(University of Illinois), Professor*
Coastal engineering, sediment transport, hydrology, hydraulic models.

Richard E. Woodring, Ph.D. *(University of Illinois), Professor and Dean of Engineering Emeritus*
Structural engineering, reinforced concrete.

Aspasia Zerva, Ph.D. *(University of Illinois at Urbana-Champaign), Associate Professor*
Lifeline earthquake engineering, seismic ground motion modeling and simulations, probabilistic engineering mechanics.

Facilities

Construction Materials Laboratory
This laboratory contains facilities for the study of concrete, asphalt, mortar, soil-cement, and timber materials, and moist cure facilities.

Engineering Geology Laboratory
This laboratory contains a large collection of museum-quality mineral, rock, and fossil specimens; seismograph and resistivity equipment; and clay mineralogy X-ray diffractometers.

Geosynthetics Laboratory
This laboratory contains a complete suite of physical, mechanical, hydraulic, endurance, and environmental test devices for assessing behavior of geotextiles, geogrids, geonets, geomembranes, and geocomposites.

HVAC and Refrigeration Laboratory
This laboratory contains complete models of heating, ventilation, air conditioning, refrigeration, and pumping system models.

Hydromechanics Laboratory
This laboratory contains a wave channel tilting flume, pipe friction equipment, bench demonstration equipment, and a beach erosion model.

Soil Mechanics and Geoenvironmental Laboratory
This laboratory contains triaxial and direct shear equipment, controlled environmental chambers, consolidation tests, flexwall permeameters, and a test bed.

Structural Models Laboratory
This laboratory contains model loading frames, microwelders, vibration testing equipment, shell fabricating equipment, and photoelastic equipment.

Electrical and Computer Engineering

General Information
Electrical and computer engineering graduate research and teaching are grouped into the following areas: computer engineering, electrophysics (including electronic devices, microwaves, fiber optics, photonics, MEMS, nanotechnology, and solid-state electronics), and systems (including controls, telecommunications, networks, image processing, signal processing, power systems, and biomedical engineering). The department offers a master's degree in electrical engineering, a master's degree in engineering/telecommunications engineering and a master's in computer engineering. The department also participates in the multidisciplinary Master of Science in Software Engineering program.

Both full- and part-time study are available. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

Core and certain other basic courses are usually offered annually. Advanced and more specialized subjects may be offered biennially. In addition, the department offers courses in new and special topics as appropriate. Information on such courses is available from the Electrical and Computer Engineering Department office, or from the department's website.

B.S. degree holders in other engineering or science disciplines may qualify for admission to the graduate program by completing prerequisites arranged in discussions with the departmental graduate advisor.

Master of Science Programs

Electrical Engineering
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 Career Integrated Education (CIE) program must complete 48 credits including 6 CIE credits.

The plan must contain a selection of core courses from the department 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.

Full-time graduate students receiving teaching or research assistantships are required to complete a master's thesis, for which up to 9 credits may be earned. Other full-time students and part-time 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.

Core Courses

Core courses present the subject matter that is basic to each curricular area. They are prerequisite to the more specialized courses. A minimum of 6 credits in core courses is required outside the student's major area, except in power systems. Students specializing in power systems are required to take ECEP 501, 502, and 503 and ECES 511, 512, and 513 (or ECES 521, 522, and 523). Each curricular group has a requirement of at least one full sequence of core courses. By area, the core courses are:

Systems

Courses		Credits
ECES 511	**Fundamentals in Systems I**	3.0
ECES 512	**Fundamentals in Systems II**	3.0
ECES 513	**Fundamentals in Systems III**	3.0
ECES 521	**Stochastic Systems I**	3.0
ECES 522	**Stochastic Systems II**	3.0
ECES 523	**Principles of Detection Theory**	3.0

Computer Engineering

Courses		Credits
ECEC 501	**Principles of Computer Engineering I**	3.0
ECEC 502	**Principles of Computer Engineering II**	3.0
ECEC 503	**Principles of Computer Engineering III**	3.0
ECEC 511	**Computer Hardware I**	3.0
ECEC 512	**Computer Hardware II**	3.0
ECEC 513	**Computer Hardware III**	3.0
ECEC 621	**Applied Computer Architecture I**	3.0
ECEC 622	**Applied Computer Architecture II**	3.0
ECEC 623	**Applied Computer Architecture III**	3.0
ECEC 631	**Computer Network Design I**	3.0
ECEC 632	**Computer Network Design II**	3.0
ECEC 633	**Computer Network Design III**	3.0

Electrophysics

Core courses		Credits
ECEE 501	**Physical Principles of Electrical Engineering I**	3.0
ECEE 502	**Physical Principles of Electrical Engineering II**	3.0
ECEE 503	**Solid-State Electronics**	3.0
ECEE 507	**Electromagnetic Field Analysis I**	3.0
ECEE 508	**Electromagnetic Field Analysis II**	3.0
ECEE 509	**Radiating Systems and Antennas**	3.0
ECEE 517	**Microwave Networks and Transmission Media**	3.0
ECEE 518	**Microwave Passive Components**	3.0
ECEE 519	**Microwave Active Subsystems**	3.0

Power Engineering

Courses		Credits
ECEP 501	**Power Systems Analysis**	3.0

ECEP 502	**Computer Analysis in Power Systems**	3.0
ECEP 503	**Synchronous Machine Modeling**	3.0

Computer Engineering
The curriculum is designed to balance the four major requirements of a master's program in computer engineering:

- *Flexibility, to address the needs of students with a variety of different backgrounds*
- *Depth, to ensure that graduates will have adequate knowledge and skills in at least one area of specialization*
- *Focus on current technological trends, to meet the immediate needs of working students as well as to adequately prepare full-time students for a real-world technological environment*
- *Strong foundations in theory, to equip the student with tools to grasp and develop new technologies and trends*

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 nonthesis option are also encouraged to engage in research, by registering for research credits (not exceeding 9 credits).

Core Requirement

The core requirement consists of two courses, ECEC 621 (High-Performance Computer Architecture) and ECEC 631 (Computer Network Design), which are the first courses of the computer architecture sequence and the networks sequence, respectively. Students must complete one of these two sequences. Because students need not have advanced knowledge beyond the undergraduate level to study either sequence, we plan to offer the sequences in alternating years. That will ensure a practical teaching load for the Computer Engineering faculty.

Sequence Requirement

A student's plan of study must include at least one three-course sequence. At present, we have available five sequences in the areas of discrete mathematics in computer engineering, switching theory, computer architecture, networks, and embedded systems.

Credits Requirement

Students choosing the nonthesis option will be required to take 18 credits of computer engineering (ECEC) courses, 6 credits of electrical engineering (ECEE, ECES, ECEP) courses, 12 credits of engineering and/or mathematics and computer science courses, 6 credits of free ECE electives, and 3 credits of approved free electives. Those choosing the thesis option will be required to take 18 in ECEC courses, 6 credits in electrical engineering courses, 12 credits of engineering and/or mathematics and computer science courses, and 9 credits in thesis. The chart below summarizes this requirement in the M.S. in Computer Engineering plan of study.

Students may choose to participate in the College of Engineering Career Integrated Education (CIE), 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 nonthesis 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 CIE option will need a total of 48 credits for graduation.

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
M.S. thesis	9.0

All students are required to take at least two courses that emphasize development of mathematical skills required in the area of computer engineering. This requirement should be satisfied in consultation with the student's advisor and the departmental graduate advisor.

Telecommunications Engineering

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

Administered by the Department of Electrical and Computer Engineering, the program also combines the expertise of the University's faculty in business, information systems, and humanities. The program combines a strong foundation in telecommunications engineering with training in other important issues such as global communications, business aspects of telecommunications, and information transfer and processing. Through its interdisciplinary approach, the telecommunications engineering program trains and nurtures the complete telecommunications engineer.

For information, please contact Dr. P. M. Shankar, Program Director, Telecommunications Engineering, at 215-895-6632 or shankar @ ece.drexel.edu.

Program of Study

The M.S.E.E./Telecommunications Engineering degree is awarded to students who demonstrate in-depth knowledge of the field. All students complete either a project in telecommunications or a six-month period of internship through Drexel's Career Integrated Education (CIE) program. 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 M.S.E.E./Telecommunications Engineering curriculum encompasses 45 or 48 credits (with the CIE option).

Students must complete 27 core credits: 6 credits in telecommunications theory, 9 credits in telecommunications engineering, 6 credits in advanced telecommunications engineering, 3 credits in telecommunications policy, and 3 credits in telecommunications management. Students may choose 12 to 15 credits of electives from the College of Engineering and up to 6 credits of graduate courses from the Colleges of Business and Administration, Information Science and Technology, and Arts and Sciences. Students also either choose to complete a 3-credit project, either theoretical or experimental, or to participate in 6 credits (6 months) of CIE.

Curriculum

Core courses		**Credits**
ECET 511	**Telecommunications I***	3.0
ECET 512	**Telecommunications II****	3.0
Telecommunications engineering requirements		
ECET 601	**Telecommunications Engineering I*****	3.0
ECET 602	**Telecommunications Engineering II********	3.0
ECET 603	**Telecommunications Engineering III*********	3.0
Advanced telecommunications engineering requirements		
ECET 611	**Advanced Telecommunications Engineering I**	3.0
ECET 612	**Advanced Telecommunications Engineering II**	
or		
ECET 613	**Advanced Telecommunications Engineering III**	3.0
Management requirement		
MIS 620	**Telecommunications Management**	3.0
Policy requirement		
T-COM 650	**Telecommunications Policy**	3.0

***Meets with ECES 521.**

****Meets with ECES 522.**

*****Meets with ECES 621.**

******Meets with ECES 622.**

*******Meets with ECES 623.**

Facilities

There are facilities for fiber-optic communications, microwave communications, and signal and image processing. Laboratories focusing on the areas of mobile communication systems and cellular communication systems are being developed.

Doctoral Program

Superior students will be considered for the program leading to the degree of Doctor of Philosophy. The program of study is individually arranged, under the supervision of a faculty advisor.

All Ph.D. applicants are required to participate in teaching, research, and the

Electrical and Computer Engineering Department's seminar program. They are required to take the Ph.D. candidacy examination within two years of joining the program. The Ph.D. candidacy examination tests their ability and readiness to pursue research in the chosen area of specialization; successful completion of this examination is required to become a Ph.D. candidate. After successful completion of the candidacy exam, students have to present a thesis proposal to the thesis advisory committee.

All Ph.D. candidates must receive the permission of a faculty committee, appointed in consultation with the graduate advisor, before undertaking the Ph.D. dissertation. To receive the Ph.D., each candidate must pass a final examination consisting of a presentation and defense of a research dissertation.

Faculty Research Interests
The following lists full-time faculty members and their areas of research interests. Prospective students are welcome to contact individual faculty members.

For a list of faculty members in the Master of Science in Software Engineering program, please see the Master of Science in Software Engineering section under Multidisciplinary Programs.

S. Basavaiah, Ph.D. *(University of Pennsylvania), Visiting Professor*
VLSI design, VLSI technology, low-power CMOS circuits, thin-film technology, interconnect technology.

Richard B. Beard, Ph.D. *(University of Pennsylvania), Professor Emeritus*
Electrophysics and biomedical: bioelectrochemistry and acoustic properties of materials, biocompatibility studies.

Nihat M. Bilgutay, Ph.D. *(Purdue University), Professor and Department Head*
Systems and biomedical: signal processing, communication theory, ultrasonic imaging, nondestructive testing.

Fernand Cohen, Ph.D. *(Brown University), Professor*
Computer vision, image processing, texture.

Richard L. Coren, Ph.D. *(Polytechnic Institute of Brooklyn), Professor Emeritus*
Electromagnetic fields, antennas, shielding, RFI, cybernetics of evolving systems.

Kapil Dandekar, Ph.D. *(University of Texas), Assistant Professor*
Application of computational electromagnetics and signal processing to the study of next-generation wireless communication systems.

Afshin Daryoush, Ph.D. *(Drexel University), Professor*
Electrophysics: telecommunications, electromagnetic fields, antennas, microwave and millimeter wave solid-state devices and circuits, microwave photonics, fiber optics, integrated optics, electromagnetic sensors, microwave spectroscopy.

Bruce A. Eisenstein, Ph.D. *(University of Pennsylvania), Arthur J. Rowland Professor*
Systems and biomedical: digital signal processing, pattern recognition, communication theory.

Robert Fischl, Ph.D. *(University of Michigan), John Jarem Professor Emeritus*
Power: systems, networks, controls, computer-aided design, power systems, solar energy.

Adam K. Fontecchio, Ph.D. *(Brown University)*,*Assistant Professor*
Electro-optics, Liquid Crystals, Polymer Dispersed Liquid Crystals, Holography, Remote Sensing, Color Filtration, Electrically Switchable Bragg Gratings

William Freedman, Ph.D. *(Drexel University), Associate Professor*
Biomedical systems, rehabilitation, neural systems, computer engineering.

Gennady Friedman, Ph.D. *(University of Maryland), Professor*
Nanoscale magnetic systems and their biological and biomedical applications, miniature nuclear magnetic resonance sensors and systems, liquid microdrop-based microelectromechanical systems (MEMS), modeling of hysteresis in complex systems, applications of hysteresis in information processing.

Eli Fromm, Ph.D. (*Thomas Jefferson University-Jefferson Medical College), Roy A. Brothers University Professor*
Bioengineering: biotelemetry, sensors, bioinstrumentation, communications, professional society activities. Engineering education/research.

Edwin L. Gerber, Ph.D. *(University of Pennsylvania), Professor and Assistant Head of the Department for Evening Programs*
Electrophysics: physical electronics, electronic devices, computerized instrumentation.

Allon Guez, Ph.D. *(University of Florida), Professor*
Robotics, control dynamic systems, intelligent control.

Peter R. Herczfeld, Ph.D. *(University of Minnesota), Lester A. Kraus Professor*
Microwaves and millimeter waves, lightwave engineering, fiber optics, solar energy, solid-state electronics.

Leonid Hrebien, Ph.D. *(Drexel University), Associate Professor*
Systems and biomedical: cardiovascular system characterization, tissue excitability measurement, acceleration effects on cardiovascular and cerebrovascular functions. Engineering education/research.

Dov Jaron, Ph.D. *(University of Pennsylvania), Calhoun Distinguished Professor of Engineering and Medicine*
Development, physiologic evaluation, and clinical implementation of mechanical devices to assist the failing heart; control and optimization of circulatory devices; computer application to patient monitoring; properties of bioelectrodes; instrumentation.

Paul R. Kalata, Ph.D. *(Illinois Institute of Technology), Associate Professor*
Systems: estimation, identification and control theory, adaptive control and filtering, computer control systems.

Moshe Kam, Ph.D. *(Drexel University), Robert Quinn Professor*
Detection and estimation, decision theory, decision fusion, robot navigation, forensic pattern recognition.

Constantine Katsinis, Ph.D. *(University of Rhode Island), Associate Professor*
Computer architecture, modeling and applications, parallel processing systems, fault-tolerant systems, operating systems, image processing and pattern recognition.

Stanislav B. Kesler, Ph.D. *(McMaster University), Associate Professor*
Systems: telecommunications, computer networks, statistics, signal processing,

adaptive array signal processing.

Timothy P. Kurzweg, Ph.D. *(University of Pittsburgh)*, *Assistant Professor*
Mixed-signal multi-domain modeling and simulation, optical interconnects, optical MEMS, optical microsystems, optical Communication, behavioral modeling, system-level simulation, free-space optics, computer architecture, VLSI, system on a chip (SOC).

Peter A. Lewin, Ph.D. *(University of Denmark, Copenhagen), Richard Beard Professor* and Director, Biomedical Ultrasound Research and Education Center
Biomedical ultrasonics, ultrasonic exposimetry, medical and industrial applications of ultrasound, piezoelectric transducers, propagation of ultrasonic waves in inhomogeneous media, biological effects of ultrasound, physical acoustics, air and underwater acoustics.

Alexander M. Meystel, Ph.D. *(ENIMS, Moscow, Russia), Professor*
Intelligent control, machine intelligence, autonomous systems, robotics.

Karen Nan Miu, Ph.D. *(Cornell University), Assistant Professor*
Power systems: power distribution system planning and operation, distribution automation, optimization techniques.

Bahram Nabet, Ph.D. *(University of Washington), Professor*
Electrophysics: compound semiconductor devices and circuits, fabrication and modeling, photonics, neural networks, vision.

Prawat Nagvajara, Ph.D. *(Boston University), Associate Professor*
Design and testing of computer hardware, fault-tolerant computing, error-correcting code.

Vernon L. Newhouse, Ph.D. *(University of Leeds, England), Disque Professor Emeritus*
Biomedical and electrophysics: ultrasonic flow measurement, imaging and texture analysis in medicine, ultrasonic nondestructive testing and robot sensing, clinical engineering.

Dagmar Niebur, Ph.D. *(Swiss Federal Institute of Technology, Lausanne), Assistant Professor*
Intelligent information processing techniques for power system monitoring and control.

Chikaodinaka O. D. Nwankpa, Ph.D. *(Illinois Institute of Technology), Professor*
Power: power systems planning and operation. Systems: modeling and control of nonlinear systems, stochastic systems theory.

Banu Onaral, Ph.D. *(University of Pennsylvania), H. H. Sun Professor and Director of the School of Biomedical Engineering, Science, and Health Systems*
Biomedical signal processing, complexity and scaling in biomedical signals and systems.

Stewart D. Personick, Ph.D. *(Massachusetts Institute of Technology), E. Warren Colehower Chair Professor*
Telecommunications systems, information networking, network security, optical fiber communication systems.

Athina P. Petropulu, Ph.D. *(Northeastern University), Professor*

Statistical signal processing, higher-order statistics, fractional-order statistics, communications, ultrasound image processing.

Kambiz Pourrezaei, Ph.D. *(Rensselaer Polytechnic Institute), Professor*
Applications of microelectronics to biomedicine, biomaterials.

Karkal G. Prabhu, Ph.D. *(Harvard University), Visiting Professor*
Software reliability, real-time systems, neural networks, pattern recognition.

John Reid, Ph.D. *(University of Pennsylvania), Calhoun Professor Emeritus*
Biomedical: ultrasonics and ultrasound, medical instrumentation, echocardiography.

Kevin J. Scoles, Ph.D. *(Dartmouth College), Associate Professor and Assistant Department Head for Undergraduate Studies*
Electrophysics: device fabrication, photovoltaics, solid-state physics, digital circuit design, computer-aided design.

Harish Sethu, Ph.D. *(Lehigh University) Assistant Professor*
Computer networks, parallel computer architectures, parallel and distributed computing.

P. Mohana Shankar, Ph.D. *(Indian Institute of Technology, Delhi), Allen Rothwarf Professor and Assistant Department Head for Graduate Studies*
Telecommunications, mobile systems, fiber optics, speckle, biomedical ultrasonics.

Ernest L. Stagliano, Jr., M.S.E.E. *(Drexel University), Lecturer*
Power, protective relaying, systems, circuits.

Hun H. Sun, Ph.D. *(Cornell University), Professor Emeritus*
Systems and signals in biomedical control systems.

Lazar Trachtenberg, Sc.D. *(Technion Israel Institute of Technology), Professor*
Design and testing of hardware (multilevel gate arrays), fault-tolerant computing, design of reliable suboptimal digital filters.

Oleh J. Tretiak, Sc.D. *(Massachusetts Institute of Technology), Robert C. Disque Professor and Assistant Department Head for Development*
Computers and image processing: microcomputer image processing workstation, computer tomography, pattern recognition, computer systems.

Birsen Yazici, Ph.D. *(Purdue University), Assistant Professor*
Signal processing, wavelets, network traffic modeling, biomedical imaging.

Ruifeng Zhang, Ph.D. *(Stevens Institute), Assistant Professor*
Signal processing, networking, communications, wireless systems.

Facilities
Information about ECE laboratories can be accessed at the *Electrical and Computer Engineering* page.

ECE Computer Operations and Services Center

The department's major computer facility houses a Sun SparcServer 690MP and a Sun Ultra Enterprise 4000 operating under UNIX. Various software packages are available for graduate and undergraduate use, including MATLAB, Maple, Mentor

Graphics, and C and Fortran compilers. These applications are also available to research labs in the ECE department. An X-terminal facility is available for students to access these UNIX-controlled applications.

Public Computer Labs

The department has both Windows NT and Macintosh computer facilities available for use by ECE students. These facilities can be accessed 24 hours a day, seven days a week, through the security system built into the student ID card. The computer systems have a broad assortment of applications used for class or lab work, as well as the common applications used for general computing projects.

Research and Teaching Laboratories

Antenna Laboratory
Room 7-506, Dr. Afshin Daryoush, 215-895-2362
The Antenna Laboratory comprises transmit assembly, an anechoic chamber, receiver subassembly, and Macintosh controller. The anechoic chamber is designed for planar antenna measurements over 8-18GHz and is totally shielded, with quiet zone of -40dB for 1 foot diameter sphere. The antenna facility is fully automated with the computer-controlled measurements of radiation pattern, gain, and polarization. A diagonal horn is the source antenna and the gain measurement is on the basis of the gain averaging technique. The transmitter assembly is mounted on a computer-controlled translational stage with 12 inches long travel. The type of polarization is determined by rotating the linearly polarized source antenna and measuring the axial ratio. At present, the type of polarization is determined using axial ratio measurement, and it is planned by adding the phase measurement system. The antenna under test is mounted on receiver pedestal and the received power is monitored by an automated spectrum analyzer. The radiation pattern is measured in azimuth (-90o to +90o) and elevation (-45o to +45o) directions for phased array antennas of 9x9 square inches. The received signals are processed using a specialized test routine, developed as MAC application. The measured parameters are displayed on the screen either in rectangular or polar formats.

Center for Microwave/Lightwave Engineering
Room 7-517, Director: Dr. Peter Herczfeld, 215-895-2256
The goal of this newly established Center is to establish a premier research and education center for the advancement of microwave-lightwave engineering. Microwaves and photonics are among the fastest growing disciplines in engineering. The extensive national effort in monolithic microwave integrated circuits (MMIC) will have a profound effect on high-speed, high-frequency analog and digital systems. The heart of this facility is the HP 8510 network analyzer, a Tektronics Spectrum Analyzer, various power meters, high-sensitivity microwave bridges, and a variety of active and passive components. There are facilities to fabricate and test hybrid microwave and millimeter wave circuits. The optical equipment includes five optical tables, an assortment of computer-controlled positioners, high-precision positioners, dye laser, pulsed flag laser, a number of high-speed semiconductor lasers and detectors, CCD cameras, and an image processing facility. Several CAD programs such as Touchstone and Supercompact are available for research and teaching.

Cleanroom Microfabrication Facility
Room 27-334/334A, Dr. Bahram Nabet, 215-895-6761, Dr. Kevin Scoles, 215-895-2259
The ECE Department Cleanroom facility is used to develop novel microelectronic materials, processes, and devices. It encompasses an area of 1,800 square feet with a rating of Class 10,000. The cleanroom contains a variety of thin film manufacturing and diagnostic equipment, such as thin film evaporators, a diffusion

furnace, photoresist spinner, mask aligners, wafer scribing and dicing equipment, and an ellipsometer. Additional equipment suitable for the manufacture and packaging of hybrid circuits is also available. Device characterization and testing equipment is also available and includes a computerized station with femto-Farad and pico-Amp resolution. Faculty, graduate, and undergraduate students use the facility in their research and education programs.

Communications and Signal Processing Laboratory (CSPL)
Room 7-707, Dr. Athina P. Petropulu, 215-895-2358
This facility is dedicated to research in statistical signal processing. Some of the current projects are communications (blind equalization), higher-order spectra analysis (system identification, signal reconstruction, low-rank estimators of higher-order statistics), alpha-stable processes and relationship with 1/f signals, ultrasound imaging (resolution improvement of ultrasound image for breast cancer detection at early stages, attenuation estimation), and earthquake engineering (site response analysis). The lab is equipped with:

- Sun Ultra ENTERPRISE 2, Dual-200-MHz processors
- Sun Ultra 1, 147-MHz Processor
- Sun SparcStation 5, 110-MHz processor
- Sun SparcStation 5, 70-MHz processor
- Three (3) HDS @work Supra-66 17CH x-terminals
- Apple LaserWriter 16/600 PS

Data Fusion Laboratory
Room 7-608, Dr. Moshe Kam, 215-895-6920, Dr. Paul Kalata, 215-895-2251
The Data Fusion Laboratory investigates problems in multisensor detection and estimation with applications in digital communications, radar, and target tracking. Among the projects in progress: computationally efficient parallel distributed detection, modulation recognition in digital communications over fading channels, neural network synthesis for pattern recognition, and hardware realization of a data fusion center for binary detection and target tracking. The laboratory also participates in joint efforts with the Power Systems Laboratory to develop automatic contingency selection algorithms using combined neural network/expert system architectures.

Digital Signal Processing Laboratory
Room 7-610, Dr. Birsen Yazici, Dr. Nihat Bilgutay, 215-895-1988
This laboratory is outfitted with state-of-the-art equipment through recent National Science Foundation, Air Force Office of Scientific Research, and Office of Naval Research grants. The present instrumentation is suitable for acquisition and analysis of high-frequency ultrasonic data in an efficient and reliable fashion. The existing facility is rapidly being expanded with additions necessary to complement and enhance current capabilities.

Electric Power Engineering Center
Room 2-048, Dr. Karen Miu, 215-895-6207, Dr. Dagmar Niebur, 215-895-6749, Dr. Chika Nwankpa, 215-895-2218
This newly established facility makes possible state-of-the-art research in a wide variety of areas, ranging from detailed theoretical model study to experimental investigation in its high voltage laboratories. The mission is to advance and apply scientific and engineering knowledge associated with the generation, transmission, distribution, use, and conservation of electric power. In pursuing these goals, this center works with electric utilities, state and federal agencies, private industries, nonprofit organizations and other universities on a wide spectrum of projects. Research efforts, both theoretical and experimental, focus on the solution of those problems currently faced by the electric power industry. Advanced concepts for electric power generation are also under investigation to ensure that electric power

needs will be met at the present and in the future.

Imaging and Computer Vision Center
Room 7-110, Director: Dr. Fernand Cohen, 215-895-1420
The ICVC pursues research in the fields of imaging, computer vision, image processing, image pattern recognition, and the extraction of quantitative data from images. Work is performed in a number of areas, ranging from model-based vision systems to expert systems for knowledge-based vision. Current projects include three-dimensional analysis in neuroscience, grain counting, tissue characterization based on ultrasound images, 3-D shape extraction from textural information and contours, robust and unsupervised region-based and edge-based segmentation of images of 3-D scenes, and geometrical matching and registration with distance functions. A unique characteristic of the center is the emphasis on the model-based/ decision theoretical approach to imaging and computer vision, where stochastic, algebraic, and geometric models are considered for representing objects of interest and the data resulting from sensing them.

Laboratory of Applied Machine Intelligence and Robotics
Room 7-607, Dr. Alexander Meystel, 215-895-2220
The Laboratory of Applied Machine Intelligence and Robotics (LAMIR) focuses its activities on the development of new knowledge in the area of intelligent control (application of AI and OR methods in control systems). The emphasis is on domain of knowledge representation, planning and control of autonomous systems, systems with incomplete and/or inadequate information (knowledge) representation, and systems with perceptual and cognitive properties that are supposed to enhance to corresponding capabilities of human beings. Two faculty members and about ten graduate students constitute the permanent body of the LAMIR. The laboratory is equipped with PCs and an IBM-9000, SYMBOLICS (LISP machines), and others. The research results are being tested on several multilink manipulators including PUMA, IBM gantry robot, and others. Special test-beds include plane robotic arms, a mobile cart with inverted pendulum, mobile robot with ultrasonic “vision,? etc. Many experimental set-ups are based on neural networks applied for learning and intelligent control.

Microwave-Photonics Device Laboratories
Room 7-506A, Dr. Afshin Daryoush, 215-895-2362
The laboratory is equipped with fiber-optic and optical equipment including high-speed semiconductor laser diodes up to 20 GHz and high-speed pin photodiode up to 25 GHz in 820nm, 1300nm, and 1500nm range, single-mode and multimode 3dB optical couplers, fiber-optic polishing and connectorizing equipment, and optical power meters. A fiber etching platform and fusion splice is also available to make lenses on single-mode and multimode fibers. Intercontinental test fixtures are used for testing of MMIC circuits and solid-state transistors. Furthermore, a specialized test fixture is developed for testing of ASIC circuits up to 10 Gb/s. Our computer facilities include Sun workstations and Classic servers networked to several PCs. Several of the state-of-the-art microwave and electromagnetic CAD packages such as HP-EESOF, HFSS, and ADS software are available. Furthermore, specialized software such as Agile, Scope, and Cadence are available through networking.

Millimeterwave/Lightwave Engineering Laboratory
Room 7-503B, Dr. Peter Herczfeld, 215-895-2256, Dr. Afshin Daryoush, 215-895-2362
This laboratory is equipped with state-of-the-art test equipment for the characterization of electrical and optical passive and active circuits. Facilities include HP8510 automated vector network analyzer (45MHZ–26.5GHZ), Tektronix 7854 computer controlled TDR/sampler scope with 25ps resolution, Tektronix 2756P GPIB controllable spectrum analyzer with external mixers up to 60 GHz, Tektronix 7L18 spectrum analyzer and associated external mixers up to 60 GHz, synthesized

sweeper HP8340B and sweep oscillator HP8350 (10 KHz–26.5 GHz), synthesized attenuators, and passive microwave and millimeter wave components. There are a GPIB-controlled optical spectrum analyzer covering 600–1750nm with resolution of 0.1nm from Ando, focusing aspherical lenses, laser diode collimating lenses, and assortments of interference filters and neutral density filters, and a scanning Fabry-Perot. The laboratory is also equipped with a tunable dye laser diode (500–960nm) and a pulsed Nd-YAG laser from Spectra Physics for semiconductor device characterizations.

Power Electronics Research Laboratory
Room 2-048, Dr. Chika Nwankpa, 215-895-2218
The Power Electronics Research Laboratory (PERL) is involved in circuit and design simulation, device modeling and simulation, and experimental testing and fabrication of power electronic circuits. The research and development activities include electrical terminations, power quality, solar photovoltaic systems, GTO modeling, protection and relay coordination, and solid-state circuit breakers. The analysis tools include EMPT, SPICE, and others, which have been modified to incorporate models of such controllable solid-state switches as SCRs, GTOs, and MOSFETs. These programs have a wide variety and range of modeling capabilities used to model electromagnetics and electromechanical transients ranging from microseconds to seconds in duration. The PERL is a fully equipped laboratory with 42 kVA AC and 70 kVA DC power sources and data acquisition systems, which have the ability to display and store data for detailed analysis. Some of the equipment available is a distribution and HV transformer and three phase rectifiers for power sources and digital oscilloscopes for data measuring and experimental analysis. Some of the recent studies performed by the PERL include static VAR compensators, power quality of motor controllers, solid-state circuit breakers, and power device modeling which have been supported by PECO, GE, Gould, and EPRI.

Scaling Signals and Systems Laboratory (SSSL)
Room 7-603/605, Dr. Banu Onaral, 215-895-2247
The Scaling Signals and Systems Laboratory (SSSL) is a research facility dedicated to basic and applied research in scaling dynamics. Scaling is ubiquitous in nature and remarkably common in physiological dynamics. The Scaling Signals and Systems Laboratory aims:

- To develop the core theory amenable to the study of complex physiological phenomena that "scale," (i.e., exhibit systematic relationships over a broad range of temporal and spatial scales)
- To translate these concepts into novel signal processing algorithms and system analysis tools to measure, analyze, identify, and model such behavior, with emphasis on physiological monitoring

Applied research projects in SSSL devoted to biomedical signals and systems and speech analysis, nondestructive testing of materials, and characterization of bioelectrode interfaces exploit emerging concepts of complex adaptive systems, self-organization, criticality, and self-similar fractals, as well as advanced methods of multiscale signals and system theory, multirate and multiresolution signal processing tools including wavelet transforms.

Supervisory Control Laboratory
Room 7-609, Dr. Moshe Kam, 215-895-6920
The Supervisory Control Laboratory investigates large-scale dynamic systems and robotic plants, using techniques that are imported from the disciplines of control theory and computer science. Special emphasis is given to control via the formulation of discrete event systems with applications in power system and complex manufacturing processes. Several physical plants are used for concept demonstration and algorithm verification, among them a hopping robotic leg and a

mobile autonomous robot. Major funding for the laboratory's activities comes from the NSF and from EPRI.

Thin Film and Ion Beam Laboratory
Room 7-505, Dr. Kambiz Pourrezaei, 215-895-2260
This facility consists of two areas: (1) Reactive Sputtering Facility, and (2) Liquid Metal Ion Source Facility. The Reactive Sputtering Facility was developed with the help of RCA, the Ben Franklin Partnership/Advanced Technology Center of Pennsylvania, and Drexel University. This laboratory is equipped with various thin film deposition and characterization equipment. There are three reactive sputter deposition systems which are being used for various microelectronics and thin film research and teaching activities. One of these systems (MCR 8501 rf sputtering system) is being used to support the research on electrical, dielectric, and optical properties of various thin films, especially aluminum nitride (AlN), zinc oxide (ZnO), and titanium nitride (TiN). The other system (Varian 980-2404 rf sputtering system) is a multitarget planar sputtering system and is being used for research in multilayer metallization systems and diffusion barriers in silicon-on-sapphire (SOS) integrated circuits. These systems are equipped with extensive control electronics and plasma diagnostics such as glow discharge mass spectrometer (GDMS), quadrupole residual gas analyzers (RGA), langmuir probes, and electron/ion energy analyzers. The third system (Veeco VS-775 automatic high vacuum station) has been modified and is dedicated to fiber coating projects. The Liquid Metal Ion Source Facility (LMIS) was established for fabricating, testing, and operating liquid metal ion sources. These facilities include two high-vacuum systems.

Ultrasound Transducer Research Facility
Room 7-704, Dr. Peter Lewin, 215-895-2361
This 600-square-foot facility has water, work benches for electronic construction and testing, computer controlled scanning tanks, and a broad range of modern test high speed digitizers, ultrasound pulsers and receivers, digital oscilloscopes, and micro/minicomputers. Moreover, there is distilled water supply equipment, experimental shock wave generator, and several calibrated miniature PVDF receivers together with standard pulse-echo imaging transducers. The piezoelectric receivers include both wideband needle-type hydrophone probe and a spot poled membrane hydrophone developed for both calibration and testing, and the shock wave measurements.

Comprehensive acoustic characterization of the transducers and materials can be carried out using Time Delay Spectrometry (TDS) measurement set-up. Small workshop facilities are established in the laboratory allowing prototype transducer assembly. In addition, there is a high-voltage poling facility.

VLSI Design Facility
Room 7-404, Dr. Prawat Nagvajara, 215-895-2378
This facility is dedicated to custom and standard cell designs. Equipment includes two Valid Logic Systems workstations for layout, schematic capture and simulation, eight-pen plotter, and line printer. Technologies supported include CMOS, NMOS, and hybrid circuits. Participation in MOSIS facilitates the fabrication of devices.

Engineering Geology

General Information
The graduate program in engineering geology seeks to educate geologists, geoscientists, and geotechnical engineers in several areas of applied geology. Students are encouraged to improve their ability to quantify the engineering and environmental problems and hazards created by geologic materials, processes, structure, and history. They are also encouraged to develop an understanding of the engineering efforts required to characterize and overcome geologic hazards. The curriculum emphasizes the importance of practical experience through frequent reference to case histories drawn from the experience of the faculty and from the literature of engineering and environmental geology.

Admission
In addition to meeting Drexel's 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, applicants to this program should hold a bachelor's degree in geology, engineering geology, geoscience, or the equivalent. Students may apply to begin the program in any term. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study.

The program offers a limited number of teaching and research assistantships.

Master of Science Program
A thesis is required for all full-time students and is an option for part-time students. Because of the similarities between engineering geology and several other Drexel programs, it is possible for students to develop a dual master's. Such opportunities may be available between engineering geology and civil engineering, engineering management, and environmental engineering or science.

The M.S. degree requires 48 quarter credits. The program is flexible, allowing students the freedom to pursue individual goals. Students choose one of three areas of concentration: engineering geology and geotechnics, hydrogeology and hydrology, and environmental geology. All students must complete MATH 544 (Advanced Engineering Mathematics I) or Geoapplications or an equivalent selected when their plan of study is prepared. Students typically complete four or five electives. Students preparing a thesis can earn up to six credits for the research and writing.

Doctoral Program
A doctoral program in engineering geology can be developed with the cooperation of the Civil Engineering Department. Students considering such a program should contact the program director.

Faculty Research Interests
The faculty consists of the program director, participating faculty from other Drexel departments and the University of Pennsylvania, and adjunct faculty. Adjuncts include working professionals, most of whom are licensed professional geologists (PG) or professional engineers (PE).

Seyed Ali, Ph.D. *(University of Pennsylvania), PE*

Geostatistics and geomechanics.

Craig R. Calabria, Ph.D. *(Salford University, U.K.), PE*
Geotechnical and geoenvironmental engineering.

Gary P. Crawford, M.S. *(Drexel University)*
Environmental engineering, hazardous wastes.

Edward L. Doheny, Ph.D. *(Indiana University), PG, Program Director*
Engineering geology, hydrology, geophysics, clay mineralogy.

George E. Duda, M.S.C.E., M.S.E.G. *(Drexel University), PE*
Geomechanics.

Chad H. Freed, M.S.C.E., M.S.E.G. *(Drexel University), PG*
Engineering geology, geophysics, groundwater modeling.

Robert Giegengack, Ph.D. *(Yale University), PG*
Environmental geology, climatology, volcanology, seismology.

Harry G. Harris, Ph.D. *(Cornell University), PE*
Structural dynamics, earthquake engineering.

Roy E. Hunt, M.S. *(Columbia University), PE, PG*
Engineering and environmental geology.

Jack Hwang, Ph.D. *(University of Minnesota)*
Hydraulics, groundwater.

Dave Kargbo, Ph.D. *(University of Nebraska)*
Soil geochemistry.

Robert M. Koerner, Ph.D. *(Duke University), PE*
Geotechnical and foundation engineering, geosynthetics.

Kenneth Lacovara, Ph.D. *(University of Delaware)*
Stratigraphy, paleontology.

Matthew Lahvis, Ph.D. *(Drexel University)*
Groundwater modeling and vapor transport.

Joseph P. Martin, Ph.D. *(Colorado State University), PE*
Geotechnical engineering, environmental geotechnology, ecological impacts of infrastructure and mining.

Carl Mastropaolo, M.S. *(Drexel University)*
Computational methods in geology and hydrology.

Dennis Mohan, M.S.C.E. *(Drexel University), PE*
Structural geology, geotechnical engineering.

Margaret Passmore, M.S. *(Drexel University)*
Geochemistry.

Gary Paulachok, M.S. *(Drexel University), PG*
Groundwater, hydrology.

Sandor Popovics, Ph.D. *(Purdue University), PE*
Construction materials, mineral aggregates.

Timothy Ruga, M.S. *(Drexel University), PE*
Groundwater and solute transport modeling.

Gary Snyder, M.S.C.E. *(Drexel University), PE, PG*
Physical geology, geophysics.

J. Richard Weggel, Ph.D. *(University of Illinois), PG*
Coastal engineering, coastal geomorphology, coastal processes.

Aspasia Zerva, Ph.D. *(University of Illinois at Urbana-Champaign)*
Earthquake engineering.

Facilities

Construction Materials Laboratory
This laboratory contains facilities for the study of concrete, asphalt, mortar, soil-cement, and timber materials, and moist cure facilities.

Engineering Geology Laboratory
This laboratory contains a large collection of museum-quality mineral, rock, and fossil specimens; seismograph and resistivity equipment; and clay mineralogy X-ray diffractometers.

Hydromechanics Laboratory
This laboratory contains a wave channel tilting flume, pipe friction equipment, bench demonstration equipment, and a beach erosion model.

Soil Mechanics Laboratory
This laboratory contains triaxial and direct shear equipment, controlled environmental chambers, consolidation tests, flexwall permeamotors, and a large-scale test bed.

Structural Dynamics Laboratory
This laboratory contains an MB vibrator with 3,500-pound capacity and a maximum of 45.3 g’s, sinusoidal or random programmed loading, and shake table.

Structural Models Laboratory
This laboratory contains model loading frames, microwelders, vibration testing equipment, shell fabricating equipment, and photoelastic equipment.

Structural Testing Laboratory
This laboratory contains universal testing machines with 150,000- and 300,000-pound capacity and test beds with MTS dynamic load equipment.

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 Ph. D. in engineering.

Admissions

In addition to meeting Drexel's general requirements for admission, which include at least a 3.0 GPA for the last two years of undergraduate study and for any graduate-level study undertaken, applicants to the Master of Engineering program are required to hold a Bachelor of Science degree in an engineering discipline from an accredited institution or the 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.

Applicants are evaluated on the basis of their academic and professional background, as well as on letters of recommendation and standardized test scores. The General (Aptitude) Test of the Graduate Record Examination (GRE) is required for applicants pursuing full-time study. Applicants whose native language is not English 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).

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 Career Integrated Education (CIE) 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 CIE 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
	CIE	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

Facilities

- Automation Laboratory
- CAD/CAM Laboratory
- Computer-Aided Manufacturing Laboratory
- Design and Manufacturing Center Facilities
- Metal Forming Laboratory
- Polymer Processing Laboratory

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Materials Engineering

General Information

The graduate program in materials engineering provides a thorough grounding in the fundamental behavior of ceramics, metals, and polymers. Emphasis is also given to the application of concepts and basic principles in the selection, design, processing, and use of engineering materials. Special topics are offered to complement the programs of graduate research. Research is primarily in the areas of composite materials, functional materials, materials processing, materials synthesis, and structural materials.

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. However, nonengineering graduates must take an appropriate number of undergraduate engineering courses to supplement their background.

Graduate work in materials 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 the program, consists of an oral presentation based on a completed literature review of topics closely related to the student's potential research area.

Master of Science Program

A total of 45 credits is required for the M.S. degree. These include five required core courses on the structure and properties of metals, polymers, and ceramic and electronic materials; the thermodynamics of solids; and the mechanical behavior 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 (involving a research proposal) is required.

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

Doctoral Program
The graduate school requires at least 90 credits for the Ph.D. degree. An M.S. degree is not a prerequisite for the Ph.D. degree, but does count as 45 credits toward the 90-credit requirement. No additional courses are required for students entering the department with an M.S. degree. Students entering the department at the B.S. level must satisfy the course requirements for the M.S. degree.

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

In addition to the graduate seminar required of all graduate students, doctoral program students must pass a candidacy examination. This consists of two parts, a written part and an oral part. The written part consists of a four-hour examination covering the materials core course, and a four-hour examination in a specific subject area selected by the student in consultation with his or her faculty advisor and subject to approval by the department's graduate committee.

Faculty Research Interests
Michel W. Barsoum, Ph.D. *(Massachusetts Institute of Technology), Distinguished Professor*
Electrical properties of ceramics, metal-ceramic and ceramic-ceramic interfaces and interactions, high-temperature degradation of ceramics and metals, in situ processing of ceramic/ceramic composites.

Roger D. Doherty, D.Phil. *(Balliol College, Oxford University), Professor*
Structural transformations and processing of metals; solidification, precipitation, and coarsening; recrystallization of deformed metals, grain growth, stability of microstructure.

Mahmoud A. El-Sherif, Ph.D. *(Drexel University), Research Professor*
Characterization and NDS of materials/structures, smart and intelligent materials, fiber optics, opto-electric materials.

Amotz Geshury, Ph.D. *(North Carolina State University), Research Assistant Professor*
Testing and characterization of fibrous structures, protective clotting systems and medical application of polymers, fibers and textile materials.

Riad H. Gobran, Ph.D. *(Brooklyn Polytechnic Institute), Research Professor*
Reactive polymers, polymer structure-property relationships, polymer interactions, polymer blends and alloys, polymer recycling, elastomers.

Yury Gogotsi, Ph.D., Sc.D. *(Kiev Polytechnic), Professor*
Nanostructured materials, carbon nanotubes, diamond synthesis, pressure-induced phase transformations, ductile regime machining of ceramics and semiconductors, Raman microspectroscopy, nanoindentation.

Surya Kalidindi, Ph.D. *(Massachusetts Institute of Technology), Professor and Department Head*
Information processing, crystal plasticity, mechanics of composite materials, biomaterials.

Richard Knight, Ph.D. *(Loughborough University of Technology, England), Research Assistant Professor*
Plasma processing of materials, plasma devices and systems, thermal spray coating processes, plasma melting.

Frank K. Ko, Ph.D. *(Georgia Institute of Technology), Professor*
Engineering properties of fibrous materials, including structural mechanics and viscoelasticity; 2-D and 3-D fabric reinforced net shape composites; textile surgical implants; engineering design of industrial textiles.

Alan Lawley, Ph.D. *(University of Birmingham, England), Grosvenor Professor*
Mechanical and physical metallurgy, composite materials, powder metallurgy, materials engineering design, engineering education.

Christopher Li, Ph.D. *(University of Akron), Assistant Professor*
Microprocessing of soft matters, nano confined soft matters, semicrystalline polymers, rod-coil block copolymers, liquid crystalline materials, photonic crystals.

Michele Marcolongo, Ph.D. *(University of Pennsylvania), Assistant Professor*
Orthopedic biomaterials, resorbable polymers, bioactive materials.

Wan Shih, Ph.D. *(Ohio State University), Research Associate Professor*
Colloids, colloidal ceramics, polymers, sintering, superconductors, surfactant, mesoporous materials.

Wei-Heng Shih, Ph.D. *(Ohio State University), Associate Professor*
Colloidal ceramics, conversion of coal waste to porous materials, sol-gel processing, electroceramics.

Antonios Zavaliangos, Ph.D. *(Massachusetts Institute of Technology), Associate Professor*
Modeling and simulation of materials processing operations, power metallurgy composites, rheology of semisolid materials, reactive processing.

Facilities

Ceramic Processing Laboratory
This laboratory contains a dynamic stress rheometer, BET surface area analyzer, ultrasonicator, photoresist spinner, impedance analyzer, and transducer.

Deformation Processing Laboratory
This laboratory contains a 60-ton Baldwin press, 150-ton Dake press, cup tester, and high-pressure hydrostatic forming equipment.

Mechanical Testing Laboratory
This laboratory contains mechanical and closed-loop electrohydraulic testing machines, an instrumented impact-tester, hardness and microhardness testers, and equipment for fatigue testing and creep/stress rupture testing.

Nanomaterials Laboratory
This laboratory contains a Raman microspectrometer, nanoindenter, instrumentation for testing and manipulation of materials under microscope, high-temperature autoclaves, and furnaces for synthesis of carbon coatings and nanotubes.

Plasma Processing Laboratory

This laboratory contains power supplies up to 120 kW, plasma torches and guns, transferred arc and nontransferred arc equipment, and deposition and spray chambers.

Polymer Processing Laboratory
This laboratory contains laboratory scale extruders, injection-molding machine, rubber mill, 10,000-psi Dake press, and ultrasonic compaction machine.

Powder Metallurgy Laboratory
This laboratory contains blenders, powder characterization equipment, furnaces, vacuum hot-press, and equipment for powder consolidation.

Solidification Processing Laboratory
This laboratory contains pressure-casting stations, low- and high-temperature rheocasting machines, centrifugal casting machine, induction heaters, filtration apparatus, viscometer, and heat-treating furnaces.

Spray Forming Laboratory
This laboratory contains a Jet-Kote spray gun system, Metco thermal spray system, Osprey spray forming unit, and low-pressure plasma spraying system.

Structural Textile Laboratory
This laboratory contains six braiders, two weaving machines, two knitting machines, needled nonwoven machine, and an HP9000 computer CAD/CAM system.

Structure Characterization Laboratory
This laboratory contains scanning and transmission electron microscopes; image analyzer; optical microscopes; metallographic preparation facilities; precision dilatometer; and computerized thermal analysis facilities including DSC, TMA, TGA, and X-ray diffractometers.

Mechanical Engineering and Mechanics

General Information

The Mechanical Engineering and Mechanics (MEM) Department offers M.S. and Ph. D. degrees in mechanical engineering with three optional areas of specialization: mechanics, systems and control, and thermal and fluid sciences.

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 Career Integrated Education (CIE) program at the master's level.

Further information can be obtained from the department graduate advisor. Details of program requirements are summarized in the Mechanical Engineering and Mechanics Graduate Program departmental website.

Core Areas

All students take core courses in the department's areas of specialization as part of a comprehensive and flexible program. The core courses in each area are listed below:

Mechanics Area

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

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

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

Systems and Control Area

Robust control systems		Credits
MEM 633	**Robust Control Systems I**	3.0
MEM 634	**Robust Control Systems II**	3.0

Non-linear control theory		Credits
MEM 636	**Theory of Nonlinear Control I**	3.0
MEM 637	**Theory of Nonlinear Control II**	3.0

Real-time microcomputer control		Credits
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*		Credits
MEM 601	**Statistical Thermodynamics I**	3.0
MEM 602	**Statistical Thermodynamics II**	3.0

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

Fluid mechanics*		Credits
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.**

Master of Science Program

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

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

M.S. 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 M.S. students are strongly recommended to follow the thesis option.

Typical M.S. program	Credits
Two core-course sequences (required)	12.0
Three mathematics courses (required)	9.0
Eight technical electives (including 9 credits for thesis option)	24.0

Various mathematics courses can be used to fulfill the applied mathematics requirement, if approved by the faculty advisor and the department graduate advisor when the plan of study is filed. It is strongly recommended that students take the “engineering analysis? course sequence (MEM 800/591, /592, and /593) offered by the MEM Department during their first year of graduate study, in order to be properly prepared for the overall MEM graduate program.

Of the 24 credits of electives, at least 12 must be taken within the MEM Department. The remainder may be taken in the College of Arts and Sciences or Engineering, or in other colleges if consistent with the plan of study and approved in writing in advance by the faculty advisor. At least 15 of the elective credits must be exclusive of independent study or thesis.

All full-time M.S. students are expected to participate in the department’s seminar

program, course instruction, and other academic activities.

Self-supported full-time students can complete the master's degree requirements within one academic year. Graduate students who are also teaching or research assistants can complete the requirements within five academic terms. Under the part-time program, degree requirements may normally be satisfied within a three-year period.

Students graduating from foreign institutions who are awarded teaching assistantships in the department are required to participate in a preparatory course during August and September of their first year at Drexel. The University's English as a Second Language (ESL) Program is offered to foreign students to help them build communication skills. In some cases, additional coursework during the academic year may be required by ESL instructors and will be followed up by this department.

M.S. with Specialization

Students wishing to obtain an M.S. with specialization in one of the core areas must structure their M.S. program such that it includes a specified number of credits from the chosen area of specialization. Further details can be obtained from the department graduate advisor.

Doctoral Program

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 Ph.D. degree. The master's degree is not a prerequisite for the Ph.D., but does count as 45 credits toward the 90-credit requirement. In addition to the 45 credits normally taken for the M.S. 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 Ph.D. students are expected to participate in the department's seminar program, course instruction, and other academic activities.

Students who hold a B.S. degree and are currently enrolled in the MEM graduate program can take the Ph.D. 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 M.S. degree that has not been granted by the MEM Department can take the Ph.D. 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 Ph.D. 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 Ph.D. 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 Ph.D. degree is granted.

Furthermore, Ph.D. students may have to take technical writing courses in fulfillment of their Ph.D. requirements. Foreign Ph.D. students are subject to the same ESL requirements as M.S. students.

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

Faculty Research Interests

Jonathan Awerbuch, D.Sc. *(Technion-Israel Institute of Technology), Professor*
Mechanics of composites, fracture and fatigue impact and wave propagation, structural dynamics.

Leon Y. Bahar, Ph.D. *(Lehigh University), Professor Emeritus*
Analytical methods in engineering, coupled thermoelasticity, interaction between analytical dynamics and control systems.

Nicholas P. Cernansky, Ph.D. *(University of California at Berkeley), Hess Chair Professor of Combustion*
Pollutant formation and control in combustion systems, combustion and fuels chemistry.

B. C. Chang, Ph.D. *(Rice University), Professor*
Computer-aided design, optimal controls, dynamic system analysis, signal processing.

Y. Cho, Ph.D. *(University of Illinois at Chicago), Professor*
Heat transfer, fluid mechanics, non-Newtonian flows, rheology, biofluid dynamics, acoustics, helicopter flows, advanced battery, industrial sensors.

Mun Young Choi, Ph.D. *(Princeton University), Professor, Interim Department Head and Associate Dean*
Combustion, soot processes, optical diagnostics.

Pei C. Chou, Ph.D. *(New York University), Billings Professor Emeritus of Mechanical Engineering*
Material response due to impulsive loading, wave propagation in isotropic and composite materials, manufacturing technology.

Jaydev Desai, Ph.D. *(University of Pennsylvania), Assistant Professor*
Medical robotics, motion planning, haptics and telepresence.

Bakhtier Farouk, Ph.D. *(University of Delaware), Professor*
Convective heat transfer, phase change problems, computational fluid dynamics, turbulence modeling, combustion, radiative heat transfer, multiphase flows.

Selcuk I. Guceri, Ph.D. *(North Carolina State University), Professor and Dean*
Composite material processing and manufacturing.

Ali A. Houshmand, Ph.D. *(University of Michigan at Ann Arbor), Professor*
Multivariate statistics, forecasting, statistical pattern recognition, quality engineering, simulation analysis.

Harry G. Kwatny, Ph.D. *(University of Pennsylvania), Raynes Professor of Mechanical Engineering*
Dynamic simulation, stochastic optimal control, control of electric power plants and systems.

Alan C. W. Lau, Ph.D. *(Massachusetts Institute of Technology), Professor and Graduate Advisor*
Computational mechanics, finite-element method, mechanisms and mechanics of deformation, fracture of structural materials, computer-aided engineering.

David L. Miller, Ph.D. *(Louisiana State University), Associate Professor*
Chemical kinetics, chemistry of combustion processes, incineration of halogenated hydrocarbons, parameter estimation techniques.

Richard W. Mortimer, Ph.D. *(Drexel University), Professor Emeritus*
Impact and wave propagation in isotropic and composite materials, structural dynamics, solid mechanics.

Gordon D. Moskowitz, Ph.D. *(Princeton University), Professor Emeritus*
Biomechanics, dynamics, design, applied mathematics.

Paul Y. Oh, Ph.D. *(Columbia University), Assistant Professor*
Systems and controls, machine vision, mechatronics, visually servoed robotics, robot hands, sensor fusion.

Howard Pearlman, Ph.D. *(Northwestern University), Assistant Professor*
Microgravity, combustion, thermodynamics, fluid dynamics.

Gary A. Ruff, Ph.D. *(University of Michigan), Associate Professor*
Two-phase flow phenomenon, optical diagnostic methods, digital image analysis, combustion, and convective heat transfer.

Rahamim Seliktar, Ph.D. *(University of Strathclyde, Scotland), Assistant Professor*
Musculoskeletal biomechanics, human locomotion, artificial limbs, ergonomics and studies of occupational injuries resulting from cumulative trauma, dynamics of ground vehicles.

Sorin Siegler, Ph.D. *(Drexel University), Professor*
Orthopedic biomechanics, control and dynamics of human movements, robotics.

Horacio Sosa, Ph.D. *(Stanford University), Associate Professor*
Theoretical and computational solid mechanics, electrodynamics of continuous media, smart materials and structures, fracture mechanics.

Wei Sun, Ph.D. *(Drexel University), Pei Chi Cho Assistant Professor*
Integrated CAD/CAE/CAM, concurrent engineering and rapid prototyping, FEM and design optimization, composites and smart materials.

Tein-min Tan, Ph.D. *(Purdue University), Associate Professor*
Composite materials, finite-element analysis, mechanics, structural dynamics, computer-aided design and computer-aided manufacturing.

Donald H. Thomas, Ph.D. *(Case Institute of Technology), Professor Emeritus*
Biocontrol theory, biomechanics, fluidics and fluid control, vehicle dynamics, engineering design.

Fu-Kang Tsou, Ph.D. *(University of Minnesota), Professor Emeritus*
Fluid mechanics, heat transfer, flow and heat transfer in separated regions.

Albert S. Wang, Ph.D. *(University of Delaware), Soffa Professor of Mechanical Engineering*
Finite elasticity, mechanics of composite materials, structural dynamics.

David Wootton, Ph.D. *(Georgia Institute of Technology), Assistant Professor*
Biofluidics, blood clotting, application of fluid mechanics in medical diagnosis.

Ajmal Yousuff, Ph.D. *(Purdue University), Associate Professor*
Modeling and control of large-scale systems, estimation and identification, algebraic and geometric theory of optimal and suboptimal control.

Jack G. Zhou, Ph.D. *(New Jersey Institute of Technology), Associate Professor*
CAD/CAM, computer-integrated manufacturing systems, manufacturing processes, rapid prototyping, system dynamics and automatic control, fractal geometry-engineering applications, tribology, precision instrumentation and measurement.

Facilities

Biomechanics Laboratory
Emphasis in this laboratory is placed on understanding the mechanical properties of human joints, characterization of the mechanical properties of biological materials, studies of human movements, and design and development of artificial limbs. Facilities include a 3-D kinematic measuring system, Instron testing machine, and microcomputers for data acquisition and processing. Additional biomechanical laboratory facilities are available at MossRehab Hospital.

Combustion and Fuels Chemistry Laboratory
Emphasis in this laboratory is placed on developing an understanding of both the chemical and physical factors that control and, hence, can be used to tailor combustion processes for engineering applications. Facilities include continuous spectroscopic reaction monitoring systems, static reactors, combustion bombs, flat flame burner systems, flow reactors, and complete analytical and monitoring instrumentation.

Combustion Emissions/Engine Laboratory
In this laboratory the effects of engine operating variables, fuel type, ambient conditions, and control devices on engine performance and emissions are studied. The laboratory contains both diesel and spark ignition engines, as well as extensive engine and emissions monitoring instrumentation, including dynamometers and continuous gaseous emission analyzers. The laboratory has a high-pressure flow reactor for detailed kinetic studies of hydrocarbon oxidation processes in engines.

Composite Mechanics Laboratory
Emphasis in this laboratory is placed on the characterization of performance of composite materials. Current interest includes damage mechanisms, failure processes, and time-dependent behavior in resin-, metal-, and ceramic-matrix composites. Major equipment includes servo-hydraulic and electromechanical Instron testing machines, strain/displacement monitoring systems, environmental chambers, microcomputers for data acquisition and processing, composites fabrication facility, interferometric displacement gauge, X-radiography, and acoustic emission systems.

Heat and Mass Transfer Laboratory
Emphasis in this laboratory is placed on the study of convective heat transfer

problems using short-duration facilities, including a shock tunnel and a Ludwieg wind tunnel. The topics of fluid mixing, separated flow, and flow development are being studied. A real-time data acquisition system utilizing an LSI-11 minicomputer combined with the VAX 11/750 system is used. A flow visualization technique is available.

Heat Transfer Laboratory
The heat transfer laboratory is outfitted with an array of instrumentation and equipment for conducting single- and multiphase heat transfer experiments in controlled environments. Facilities include computer-controlled data acquisition (LabVIEW and MacAdios) systems, a Newport holographic interferometric system with associated lasers and optics, image enlargers, power amplifiers, precision voltmeters, slip-ring assemblies, and an IBM RISC/6000 workstation for large-scale computing and simulation. A draft-free room is available with independent temperature control for carrying out natural convection experiments. An experimental test-rig is available for studying heat transfer from rotating surfaces. A bubble column has been recently built to study multiphase flow and heat transfer problems. Facilities are also available for measuring thermal conductivities of thin films using a thermal comparator.

Industrial Robot Performance Laboratory
Emphasis in this laboratory is placed on determining the relationship between robot design parameters and performance criteria. Facilities include an IBM RS/1 industrial robot, an IBM PC/AT microcomputer, a four-channel Fourier analyzer, modal analysis software, and a three-dimensional kinematic measurement system.

Microcomputer Controls Laboratory
This laboratory provides an environment conducive to appreciating aspects of systems and control through hands-on experiments. They range from data acquisition and processing to modeling of dynamical systems and implementing a variety of controllers to control systems, such as DC motors and the inverted pendulum. Facilities also include microcontrollers such as Basic Stamp and the Motorola 68HCI 1. Active research is being conducted on control reconfiguration in the event of actuator failures in aircrafts.

Microgravity Combustion and Fluid Mechanics Laboratories
The emphasis of the Microgravity Combustion and Fluid Mechanics Laboratories is on providing fundamental understanding of reacting and non-reacting flows. The laboratory is equipped with optical diagnostics equipment to measure soot concentration, temperature, radiative emission, and high-speed videography. Facilities for high-resolution imaging and image processing are also available. Specific research topics include sooting and radiative emission of droplet combustion, measurement of soot optical properties, cool flames in microgravity, microgravity fluid mechanics, and droplet cluster combustion in microgravity.

Non-Newtonian Fluid and Heat Transfer Laboratory
Emphasis in this laboratory is placed on the study of hydrodynamic and thermal performance of various non-Newtonian viscoelastic fluids in complex flow geometries. Facilities and equipment include a 20-foot-long recirculating flow loop with a 500-gallon reservoir tank and a thermal conductivity measurement cell. A complete data acquisition system provides fully automated experimental operation and data reduction. A state-of-the-art finite element code FIDAP running on a CDC 180 computer provides three-dimensional flow and heat transfer simulations of flows in complex geometrics, with a complete post-processing graphic capability backed by template.

Polymer Processing Laboratory

This laboratory is devoted to understanding the basic controlling parameters in polymer processing and the procedures for communicating between the automated processing machine and the rest of the manufacturing facilities, such as the material handling system and the intelligent monitoring system. Facilities include a BOY 55-ton injection molding machine with necessary equipment for processing fiber-reinforced polymers, an IBM microcomputer for data acquisition and control, a Macintosh II microcomputer with software for mold design and process simulation, a Brookfield digital viscometer, and a Tinius Olsen tensile strength tester for material property evaluation.

Program for Robotics, Intelligent Sensing, and Mechatronics (PRISM) Laboratory

This laboratory was founded in 2001. Primary research interests are human augmentation, medical robotics, visual servoing, motion planing, mechatronics, mobile robotics, and sensor fusion. The PRISM laboratory is equipped with the latest technology and equipment that facilitate cutting-edge research in medical robotics and vision-based controls. Major equipment includes a robotic arm, haptic interface devices, and stereo vision hardware.

Rheology Laboratory

Emphasis in this laboratory is placed on developing tools for rheological property measurement of various non-Newtonian fluids, including friction-reducing viscoelastic fluids, molten polymers, coal-water slurries, ceramic slurries, and bonding cements for biomedical applications. A capillary tube viscometer, falling ball and needle viscometers, and Brookfield rotating viscometer are available. In particular, the capillary tube viscometer is designed to allow fully automated operation, thus avoiding time-consuming data collection procedures. A high-temperature and high-pressure capillary tube viscometer is under development, so that viscosities of advanced polymer materials can be measured at relatively high temperatures and shear rates.

Spray Combustion Laboratory

In this laboratory the atomization, mixing, and combustion processes of liquid sprays in turbulent swirl air flows are studied. Of particular interest are advanced gas turbine concepts such as lean direct injection (LDI). Using an image analysis technique and a Phase-Doppler/Particle Analyzer (PDPA), both qualitative and quantitative measurements of spray mixing and dispersion are performed. The emissions measurement and combustion analysis are also conducted using image analysis technique and gas chromatography (GC). Under various conditions of swirl flows and liquid spray injection in a confined geometry, combustion aerodynamics are investigated both experimentally and by using a computational method. In addition, combustion characteristics of electrically charged fuel sprays are under consideration in this laboratory. A particular application of this research is for fuel-injection internal-combustion engines. The spray pattern, the evaporation, and the combustion are strongly influenced by the charged electric density on the liquid droplet surface. Also, various methods of charging liquids with low electric conductivity are studied.

Spray Dynamics Laboratory

Work in this laboratory involves basic scientific research in the areas of turbulent flows, the combustion of liquid fuel sprays, and the development of laser diagnostics for these flows and sprays. The facilities include two monodisperse aerosol generation systems, a two-dimensional turbulent jet, and a laser Doppler velocimeter. In addition, a Rayleigh scattering system and a single particle counter have been developed in this laboratory to provide nonintrusive, in-situ measurements of gas density and droplet size distribution, respectively.

Stress Wave and Ballistics Laboratory

Master of Science in Software Engineering

General Information

Drexel University's Master of Science in Software Engineering (M.S.S.E.) 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.

The M.S.S.E. is a multidisciplinary degree sponsored by the Colleges of Arts and Sciences, Engineering, and Information Science and Technology. The program, drawing on the strengths of existing Drexel programs in computer science, engineering, and information science and technology, provides a curriculum that encompasses behavioral, managerial, and technical aspects of software engineering and attempts to synthesize—rather than differentiate—disciplinary paradigms and themes. The program is appropriate for students interested in a wide range of application domains.

Program of Study

All students in the M.S.S.E. 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 build 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 Career Integrated Education (CIE) program. The average time to complete the master's degree is two years of full-time study or three years of part-time study.

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.*
- *Applicants must have an acceptable score on the Graduate Record Exam (GRE). An applicant's undergraduate and/or graduate record may justify waiver of this requirement. For students pursuing full-time study in the engineering track, the General (Aptitude) Test of the GRE is required.*
- *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.

After consultation with an academic advisor, students found to be deficient in one or more of the above areas will be required to take up to three foundation courses (these will not count toward the degree) to prepare them for admission to the M.S.S.E. 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.

Degree Requirements

Degree requirements vary by track. All students take the required six core courses (20 credits).

Core Courses

Core courses cover topics that are essential for the practicing software engineer. Each of the three Colleges offers two specifically designed courses.

Please see the course descriptions for information about each course.

Computer science courses		Credits
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**	4.0
INFO 638	**Software Project Management**	4.0

Tracks

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

Information Science and Technology Track

Track Coordinator: Dr. Gregory Hislop, 215-895-2179, hislop @ 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 systems values, such as the human-computer interface, front-end user requirements analysis, modeling and validation, and 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 56 credits, 20 of which are from the required core. CIE is available for up to six credits. Hence, the CIE option requires

students to take six credits more than the non- CIE option. Please see the IST course listings for a full description of each course.

Required courses		Credits
INFO 608	**Human-Computer Interaction**	4.0
INFO 630	**Evaluation of Information Systems**	4.0
INFO 636	**Software Engineering Process I**	4.0
INFO 637	**Software Engineering Process II**	4.0

Distribution courses		Credits
INFO 503	**Introduction to Information Systems Analysis**	4.0
INFO 605	**Database Management I**	4.0
INFO 614	**Distributed Computing and Networking**	4.0
INFO 620	**Information Systems Analysis and Design**	4.0
INFO 646	**Information Systems Management**	4.0

Elective courses		Credits
INFO 603	**Application Programming for Information Systems**	4.0
INFO 606	**Database Management II**	4.0
INFO 607	**Applied Information and Database Technology**	4.0
INFO 616	**Computer-Supported Cooperative Work**	4.0

Computer Science Track

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

This track is designed for 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 a total of six track courses and a three-term project in addition to the 20 credits of required core courses. Of the six track courses, four courses must be from one of the six concentrations. The other two courses are electives. In addition to the six courses, students in the computer science track must participate in a three-term course project (equivalent to three courses). CIE is also available for up to 6 credits. Hence, the CIE option requires students to take 6 credits more than the non-CIE option.

Artificial intelligence concentration		Credits
CS 590	**Artificial Intelligence**	3.0

CS 770	**Topics in Artificial Intelligence**	3.0
CS 771	**Expert Systems**	3.0

Computing systems concentration		**Credits**
CS 720	**Operating Systems I**	3.0
CS 721	**Operating Systems II**	3.0
CS 740	**Computer Networks I**	3.0
CS 741	**Computer Networks II**	3.0

Database systems concentration		**Credits**
CS 750	**Database Theory I**	3.0
CS 751	**Database Theory II**	3.0
INFO 607	**Applied Information and Database Technology**	4.0
INFO 612	**Knowledge Base Systems**	4.0

Programming languages concentration		**Credits**
CS 559	**Formal Language Theory**	3.0
CS 560	**Programming Languages**	3.0
CS 761	**Compiler Construction I**	3.0
CS 762	**Compiler Construction II**	3.0

Scientific computation concentration		**Credits**
CS 680	**Special Topics: Computer Algebra I**	3.0
CS 680	**Special Topics: Computer Algebra II**	3.0
MATH 520	**Numerical Analysis I**	3.0
MATH 521	**Numerical Analysis II**	3.0

User interface software concentration		**Credits**
CS 585	**Computer Graphics I**	3.0
CS 586	**Computer Graphics II**	3.0
CS 680	**Special Topics: Graphical User Interfaces**	3.0
PSY 612	**Psychology of Human-Computer Interface Design**	3.0

Engineering Track

Track Coordinator: Dr. P. M. Shankar, 215-895-6632, shankar@ 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 25 or more credits of track courses in addition to the 20 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 M.S.S.E., including the 20 credits of core courses. Students opting for the CIE option are required to complete 48 approved credits, including 6 CIE credits.

Courses		**Credits**
ECEC 511	**Computer Hardware I**	3.0

ECEC 512	**Computer Hardware II**	3.0
ECEC 513	**Computer Hardware III**	3.0

Chemical engineering concentration		**Credits**
CHE 554	**Process Systems Engineering**	3.0
CHE 658	**Advanced Process Design**	3.0

Civil and architectural engineering concentration		**Credits**
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		**Credits**
ECEC 611	**Testing Computer Hardware I**	3.0
ECEC 612	**Testing Computer Hardware II**	3.0
ECEC 613	**Fault-Tolerant Computing**	3.0
ECEC 621	**Applied Computer Architecture I**	3.0
ECEC 622	**Applied Computer Architecture II**	3.0
ECEC 623	**Applied Computer Architecture III**	3.0
ECEC 624	**Computer-Aided Design and Graphics I**	3.0
ECEC 625	**Computer-Aided Design and Graphics II**	3.0
ECEC 626	**Computer-Aided Design and Graphics III**	3.0

NOTE: Any other ECE 600-level or above course may be eligible for credit.

Materials engineering concentration		**Credits**
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	**Credits**

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 676	**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

Faculty Research Interests
College of Arts and Sciences

Bruce W. Char, Ph.D. *(University of California at Berkeley), Professor*
Symbolic mathematical computation; algorithms and systems for computer algebra, problem-solving environments, and parallel and distributed computation.

Lloyd G. Greenwald, Ph.D. *(Brown University), Assistant Professor*
Artificial intelligence, planning, resource-bounded reasoning, anytime algorithms, robotics, sequential decision-making, real-time scheduling.

Nira Herrmann, Ph.D. *(Stanford University), Associate Professor*
Databases, expert systems, statistics.

Thomas T. Hewett, Ph.D. *(University of Illinois), Professor*
Human-computer interaction, cognitive psychology, computer applications.

R. Andrew Hicks, Ph.D. *(University of Pennsylvania), Assistant Professor*
Robotics, computer vision, catadioptics.

Jeremy R. Johnson, Ph.D. *(Ohio State University), Associate Professor*
Computer algebra, parallel computation, algebraic algorithms, scientific computing.

Werner Krandick, Ph.D. *(Ohio State University), Assistant Professor*
Computer algebra, parallel computation, computer arithmetic.

Spiros Mancoridis, Ph.D. *(University of Toronto), Assistant Professor*
Software architecture, reverse engineering, module interconnection formalisms, software visualization, software engineering education.

Jeffrey L. Popyack, Ph.D. *(University of Virginia), Associate Professor*
Operations research, stochastic optimization, computational methods for Markov decision processes, artificial intelligence, computer science education.

William C. Regli, Ph.D. *(University of Maryland at College Park), Assistant Professor*
Artificial intelligence, computer-aided design and manufacturing, Internet computing.

Ali Shokoufandeh, Ph.D. *(Rutgers University), Assistant Professor*
Theory of algorithms, graph theory, combinatorial optimization, computer vision.

Justin Smith, Ph.D. *(Courant Institute, New York University), Professor*
Parallel algorithms, artificial intelligence, computer vision.

Chunguang Sun, Ph.D. *(Pennsylvania State University), Assistant Professor*
Parallel and distributed computing, scientific computation, sparse matrix algorithms, programming languages.

College of Engineering

Nihat M. Bilgutay, Ph.D. *(Purdue University), Professor and Department Head of Electrical and Computer Engineering*
Systems; biomedicine: communication theory, ultrasonic imaging, nondestructive testing, signal processing.

Allon Guez, Ph.D. *(University of Florida), Professor*
Linear systems, nonlinear systems, robotics, optimal control.

Constantine Katsinis, Ph.D. *(University of Rhode Island), Associate Professor*
Computer architecture, modeling, and applications; parallel processing systems; fault-tolerant systems; operating systems; image processing and pattern recognition.

Alexander M. Meystel, Ph.D. *(ENIMS, Moscow, Russia), Professor*
Intelligent control, machine intelligence, autonomous systems, robotics.

Prawat Nagvajara, Ph.D. *(Boston University), Associate Professor*
Design and testing of computer hardware, fault-tolerant computing, error-correcting code.

Stewart D. Personick, Ph.D. *(Massachusetts Institute of Technology), E. Warren Colehower Chair Professor*
Systems, telecommunications, information networking, optical fiber systems.

Harish Sethu, Ph.D. *(Lehigh University), Assistant Professor*
Computers, computer architecture, switching networks and topologies, parallel and distributed computing, logic devices, computer arithmetic.

P. M. Shankar, Ph.D. *(Indian Institute of Technology, Delhi), Professor*
Telecommunications, mobile systems.

Lazar Trachtenberg, Sc.D. *(Technion Israel Institute of Technology), Professor*
Design and testing of hardware (multilevel gauge arrays), fault-tolerant computing, design of reliable suboptimal digital fibers.

Oleh Tretiak, Sc.D. *(Massachusetts Institute of Technology), Professor*
Computers and image processing: microcomputer image processing workstations, computer tomography, pattern recognition, computer systems.

College of Information Science and Technology

Michael E. Atwood, Ph.D. *(University of Colorado), Professor and Associate Dean*
Human-computer interaction, computer-supported cooperative work, organizational memory, software engineering, software project management, software process improvement.

William Evanco, Ph.D. *(Cornell University), Associate Professor*
Software engineering and systems analysis, software and process measurement, software performance.

Lewis Hassell, Ph.D. *(Drexel University), Assistant Professor*
Computer-supported cooperative work (CSCW), systems analysis and design techniques, database management systems.

Gregory W. Hislop, Ph.D. *(Drexel University), Associate Professor and Associate Dean*
Software evaluation and characterization, software development processes, software engineering education and practice, application of information technology to education.

Scott Paul Robertson, Ph.D. *(Yale University), Associate Professor*
Digital libraries, collaborative systems, cognitive systems, cognitive science, natural language comprehension, educational applications of information technologies, knowledge management, knowledge sharing.

Il-Yeol Song, Ph.D. *(Louisiana State University), Professor*
Database modeling and design, design and performance optimization of data warehouses and OLAP, database support for e-commerce and Web-based systems, and object-oriented analysis and design with UML.

June M. Verner, Ph.D. *(Massey University, New Zealand), Professor*
Software project management, software measurement, software process improvement, software development tools and techniques.

Vassilios S. Verykios, Ph.D. *(Purdue University), Assistant Professor*
Data mining, knowledge discovery in databases, data quality, database security, high-performance computing, performance analysis and evaluation.

Susan Wiedenbeck, Ph.D. *(University of Pittsburgh), Professor*
Human-computer interaction, empirical studies of programmers, interface design and evaluation, computer-supported cooperative work.

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The College of Information Science and Technology

General Information

The College of Information Science and Technology educates interdisciplinary professionals to provide information services and systems to meet a wide range of needs. The College complements its educational programs with research that increases the benefits of information science and technology for all sectors of society.

Founded in 1892, the College offers a variety of graduate and professional development programs. The master's programs are offered online and on campus.

The College also administers the information systems component of the University's multidisciplinary Master of Science in Software Engineering (M.S.S.E.) degree.

Opportunities for professional development are available through Continuing Professional Education offerings or, at the post-master's level, through non-matriculated coursework (up to 12 credits) or a certificate of advanced study (C.A.S.).

- Master's Programs
- Master of Science (M.S.) in Library and Information Science
- Master of Science in Information Systems (M.S.I.S.)
- Doctoral Program
- Professional Development Programs
- Faculty
- Facilities

Admission Requirements

In addition to the general requirements for admission to graduate studies, applicants for admission to the College of Information Science and Technology are expected to have completed a minimum of half their undergraduate coursework in the humanities (including languages), social sciences, or sciences. Those whose preparation shows an excessive amount of vocational or professionally oriented courses to the exclusion of liberal arts and sciences may not qualify for admission.

Deadlines for applications to the College of Information Science and Technology differ from those of the university. Applicants to degree programs must take the Graduate Record Examination and have the scores sent to the Graduate Admissions Office. See the College's website for specific deadlines.

Applicants who have at least a 3.2 grade point average in the last half of their undergraduate credits may be eligible for admission to master's programs without taking the GRE. This decision is made by the Associate Dean of the College after reviewing the application. Those applicants interested in graduate assistantships must submit GRE scores, since these awards are based on academic merit.

Although enrollment in the full-time programs is recommended whenever possible, part-time study is common. Courses are regularly offered in the evening and on Saturdays.

Doctoral students must enroll as full-time students for at least three consecutive terms. All applicants to the Ph.D. program are required to take the General (Aptitude) Test of the GRE. Ph.D. applicants are not eligible for a waiver of the GRE requirement.

The standard requirement for the M.S. or M.S.I.S. degree is 60 credits. Students should allow approximately five to eight terms to complete the program.

In addition to the above-mentioned requirements, entering M.S.I.S. students must have a demonstrated competency in the following: use of desktop computing systems and tools, a third-generation programming language or object-oriented language, and basic descriptive and inferential statistics. Students lacking these prerequisites may enroll in up to two foundation courses in these areas, which are offered by the College on a regular basis. These courses do not count toward the 60-credit requirement. M.S.I.S. students may not take any courses beyond INFO 503 until all prerequisites are met, and they may not take INFO 503 without a demonstrated competency in basic hardware, software, and operating systems.

All entering M.S. students must have a demonstrated competency in the use of basic desktop software.

Although the time limit set by the University for completion of any degree is seven years, the College of Information Science and Technology strongly recommends that part-time students complete the master's degree in no more than four years, for a meaningful and cohesive educational experience. Most part-time students complete the program in two to three years.

Financial Assistance
Financial aid is available to qualified students in the form of graduate assistantships, research assistantships, teaching assistantships, library assistantships, partial scholarships, and loans from the Alumni Association Loan Fund. Students may apply for financial assistance by contacting the Placement Director of the College of Information Science and Technology. Awards are announced by May 15 of each year. Awards are open only to U.S. citizens.

Placement of Graduates
The College maintains a Job Placement Office with job listings from both national and local sources. The office can aid students in finding employment at a preprofessional level, an entry-level position upon graduation, or a new position in the future.

Honor Society
Graduates with outstanding academic records are eligible for membership in Beta Phi Mu, an international honor society for information science and technology graduates, which has established its Sigma Chapter at Drexel. Outstanding students are also eligible for membership in Phi Kappa Phi, a national scholastic honor society.

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Master's Programs in Information Science and Technology (General Information)

General Goals of the College

Education

- *To provide students with a foundation for understanding, developing, and operating information systems, services, and products — including information creation, organization, communication, processing, and storage — and understanding the technical, social, and human context in which information professionals operate*
- *To relate fundamental concepts to practical applications, and to provide students with the necessary skills to function as responsive professionals in a variety of specialized roles*
- *To ground students in state-of-the-art information technologies*

Research

- *To encourage a spirit of inquiry and criticism, and to advance the theory and practice of the information professions through research and publication*

Service

- *To contribute to the growth and development of the information professions*

The general learning objectives of the College are to prepare graduates of the degree programs to:

- *Take positions of professional leadership*
- *Balance and integrate human and technical aspects of information systems, services, and products*
- *Exhibit a strong client orientation in delivering information systems, services, and products, including an understanding of the implications of a culturally diverse society*
- *Use a variety of information technologies and readily adopt appropriate new technologies*
- *Analyze people's information requirements and match them with available technologies*
- *Analyze the flow, structure, and use of information among people and within organizations*
- *Develop and defend positions on relevant social, political, and ethical issues*
- *Communicate effectively with others*
- *Develop critical thinking skills*

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Master of Science (Library and Information Science)

Learning Objectives of the M.S. Degree

Graduates of the M.S. program (library and information science) are prepared to assume leadership positions in designing, executing, and evaluating information services and products, and managing organizations that facilitate access to recorded knowledge. Their preparation encompasses the knowledge and abilities required to:

- *Describe in standard terms the major attributes of information resources*
- *Demonstrate knowledge of the structure and bibliographic control of literatures*
- *Augment access to information resources through processes such as thesaurus creation, classification, indexing, abstracting, systematic listing, and reviewing*
- *Select information resources appropriate for given audiences and develop appropriate information-seeking strategies*
- *Retrieve textual, numeric, bibliographic, image, and other information from all appropriate information sources*
- *Analyze or synthesize data and information for the client, in the form of digests, reviews of the literature, or technical reports*
- *Teach people to use information resources effectively*
- *Manage information organizations and the production of information services and products through planning, controlling, staffing, organizing, and leading*

Accreditation

The College of Information Science and Technology is a member of the Association for Library and Information Science Education, and its M.S. program (library and information science) is accredited by the American Library Association. The curriculum for the preparation of school librarians is accredited by the Pennsylvania Department of Education. The College also offers courses that advance students toward certification by the Medical Library Association.

Curriculum

The library and information science program assures students of a solid introduction to the field, a logical progression of coursework, and a wide variety of electives. The electives may also include up to 12 credit hours chosen from INFO 780 (Special Topics), INFO 799 (Independent Study), and related graduate courses taken in other departments of Drexel or another area university.

In exceptional cases a student with broad professional experience in library and information science, or previous coursework in library or information science, and well-

defined educational goals may petition for exemption from one or more required courses. This petition should be made at the time of application to the College and should include both a detailed statement of the reasons for seeking exemption and a description of the program the applicant proposes to follow at Drexel.

Courses	Credits

INFO 503	**Introduction to Information Systems Analysis**	4.0
INFO 510	**Information Resources and Services I**	4.0
INFO 511	**Information Resources and Services II**	4.0
INFO 515	**Action Research**	4.0
INFO 520	**Professional and Social Aspects of Information Services**	4.0
INFO 640	**Managing Information Organizations**	4.0
	Electives	36.0

M.S. Online

The online Master of Science (M.S.) degree with a concentration in the management of digital information (MDI) prepares information professionals to apply technology to information management processes. This is IST's second full master's degree program provided via the Internet. The online program has a strong technological focus and offers an innovative M.S. curriculum to a wider professional audience. This technical specialization is applicable to people who are interested in competitive intelligence, web development, library automation, systems librarianship, and knowledge management.

School Library Media Certification

Both the master's program and the post-master's program have course sequences that lead to Pennsylvania Certification in Library Science K to 12 in an approved Pennsylvania Department of Education program. Prior teacher certification is not required to enroll in the program. Students without certification must complete the state-required teacher preparation courses in Drexel's School of Education in addition to completing all of the state-required tests with satisfactory scores. All students are required to complete the test in library science with a satisfactory score. Faculty members supervising this certification program advise students on the course of study and recommend students for certification when all requirements have been met satisfactorily.

Professional Affiliation for M.S. Students

Student groups include the Association of Students in Information Science and Technology and the student chapters of the American Library Association, the American Society for Information Science and Technology, and the Special Libraries Association.

Master of Science in Information Systems

Learning Objectives of the M.S.I.S. Degree

Graduates of the M.S.I.S. program are prepared to assume leadership and management positions designing, developing, and delivering innovative technological solutions to information problems in a variety of contexts. Their preparation encompasses the knowledge and abilities required to:

- *Apply a systems approach to developing and delivering information systems and services:*
- *Identifying clients' information requirements*
- *Analyzing the flow and structure of information in user tasks and organizational processes with the appropriate formal tools and methods*
- *Matching requirements to technological opportunities and performing benefit/cost tradeoff analyses among design options*
- *Designing, implementing, and integrating specified system solutions*
- *Evaluating development products, including interim deliverables*
- *Developing and implementing plans for maintenance and support of operational systems*
- *Lead and manage teams of information professionals in the development of quality systems and services:*
- *Understanding the business aspects of information systems development and application in organizations*
- *Planning, controlling, staffing, and organizing to manage the processes for system development, services delivery, or system support*
- *Prepare general managers with technical information systems competencies*

Curriculum

Like the M.S. program, the M.S.I.S. program requires 60 credits. Many of the M.S.I.S. courses may be taken by M.S. students who wish to emphasize information systems within the library and information science curriculum.

The distribution of credits for the M.S.I.S. degree is as follows:

Required courses		Credits
INFO 503	**Introduction to Information Systems Analysis**	4.0
INFO 605	**Database Management I**	4.0
INFO 608	**Human-Computer Interaction**	4.0
INFO 614	**Distributed Computing and Networking**	4.0
INFO 620	**Information Systems Analysis and Design**	4.0
INFO 630	**Evaluation of Information Systems**	4.0
INFO 638	**Software Project Management**	4.0

INFO 646	**Information Systems Management**	4.0

Distribution requirements from among the following		**16.0**
INFO 602	**Text Processing by Computer**	
INFO 603	**Application Programming for Information Systems**	
INFO 604	**Object-Oriented Programming**	
INFO 606	**Database Management II**	
INFO 607	**Applied Information and Database Technology**	
INFO 610	**Analysis of Interactive System**	
INFO 611	**Design of Interactive Systems**	
INFO 612	**Knowledge Base Systems**	
INFO 616	**Computer-Supported Cooperative Work**	
INFO 617	**Introduction to System Dynamics**	
INFO 621	**Developing Multimedia Information Systems**	
INFO 622	**Content Representation**	
INFO 624	**Information Retrieval Systems**	
INFO 625	**Cognition and Information Retrieval**	
INFO 626	**Language Processing**	
INFO 627	**Requirements Engineering and Management**	
INFO 628	**Information Systems Implementation**	
INFO 629	**Concepts in Artificial Intelligence**	
INFO 636	**Software Engineering Process I**	
INFO 637	**Software Engineering Process II**	
INFO 643	**Information Services in Organizations**	
INFO 652	**Internet Information Resource Design**	
INFO 653	**Digital Libraries**	
INFO 655	**Programming Internet Information Systems**	
INFO 678	**Competitive Intelligence**	
INFO 866	**Seminar in Information Systems Research**	
	Free electives	12.0

Career Integrated Education
Students enrolled in Drexel University's master's program in information systems have the option of participating in Career Integrated Education (CIE).

Long identified with its undergraduate co-operative education program, Drexel is committed to providing this experience at the master's level. CIE is open to all students—full-time, part-time, and international—who have successfully completed a minimum of 30 credits toward their master's degree. The employment period is coordinated by the IST Placement Director in the Drexel Co-Op office and monitored by an IST faculty member and employer mentor. The career experience will match the student's academic and work background. The student will complete at least one additional course before graduation.

For students choosing this academic option, the program requires:

- *A formal orientation workshop in business protocol, ethics, résumé preparation, interview techniques, and other processes essential to professional employment*
- *A plan of study adopted prior to the CIE experience that integrates CIE and academic coursework; the academic advisor will approve this plan*
- *Employment in a position appropriate to the student's career goals*
- *Submission of a final report to the academic advisor*

Interested students should attend an information session led by the IST Placement Director as soon as possible so the enrollment and advising sequence can be started on time. These information sessions are held each term.

M.S.I.S. Online
For students whose professional or personal commitments prevent them from attending regular class meetings, the M.S.I.S. is available online. Classes are conducted using a combination of Lotus Notes and the Internet, providing an intensive learning experience with the same content and quality as the degree available through the University's traditional campus-based master's program. The online M.S.I.S. degree is limited to students pursuing the entire degree online.

Professional Affiliation for M.S.I.S. Students
M.S.I.S. student groups include the Association of Students in Information Science and Technology and the student chapter of the American Society for Information Science.

Doctoral Program

Purpose and Scope
The Ph.D. degree is not based on the accumulation of credits but represents a high level of scholarly achievement in both supervised and independent study and research. There are few fixed program requirements, and the master's degree is not a prerequisite for the Ph.D. The doctoral program has two major goals: to allow students to acquire in-depth knowledge of a specialized area within the field of information science and technology and to prepare students for a career in which research is a basic element, whether that career is in administration, research, or teaching.
Requirements

The typical program consists of a minimum of three years of full-time academic study (12 terms) beyond the master's degree, with two years of coursework and research. At least three consecutive terms of full-time resident doctoral study are required. Students may be admitted to the program for part-time study, but they must be formally accepted as doctoral students and must meet the residency requirement.

Coursework
The degree requires a minimum of 90 credits beyond the bachelor's degree for the Ph.D. degree or 60 credits beyond an applicable M.S. degree.

Courses are taken, under an approved plan of study, to ensure the development of competence in:

- *Information science and technology broadly construed*
- *One or more domains of study*
- *Research methodology*
- *Other courses as required by the plan of study*
- *Additional credits as needed*

Advancement to Candidacy
To measure proficiencies in research and to assess students' mastery of their chosen area of study, students maintain a portfolio that is reviewed on a regular basis. Candidacy is awarded based on satisfactory reviews and the presentation of an acceptable dissertation proposal.

Dissertation
The dissertation must be an original scholarly contribution to the field of information science and technology that will demonstrate the student's capacity to conduct research. The final defense of the dissertation completes the program.

Professional Development Programs

The College of Information Science and Technology offers opportunities for librarians and information specialists in related fields to update their education or develop new specialties through a variety of credit and noncredit programs.

Certificate of Advanced Study
This nondegree program provides specialized training beyond the M.S. so that practitioners can update and extend their skills and knowledge. It is not research-oriented and is not intended to provide coursework that can be applied to the doctoral degree. The program leads to a Certificate of Advanced Study awarded through the Dean's Office of the College of Information Science and Technology.

Admission Requirements

Applicants must meet all the general requirements for admission to graduate studies and the College of Information Science and Technology, except that they need not submit scores from the Graduate Record Examination. In addition, they must have completed a master's degree in library science, computer or information science, information systems, or instructional technology from an accredited program that has prepared them for advanced study in the area chosen for specialization.

Program Requirements

The program requires the completion, within a period of no more than three calendar years, of 32 credit hours in a planned program of study. At least 16 credits must be chosen from courses offered by the College of Information Science and Technology. An independent study project that integrates coursework, reading, field study, and work experience is required. A faculty advisor assists in designing and monitoring the program of study. Successful completion of the certification program requires a cumulative grade point average of 3.0.

Post-Master's Study
Applicants who hold a master's degree in library or information science may apply for admission to the College of Information Science and Technology as nondegree post-master's students in order to take a few specific courses for graduate credit. Those who hold the M.S. degree from Drexel may request readmission by contacting the Associate Dean of the College of Information Science and Technology. Others must submit completed applications to the College, indicating specific courses desired; pay the application fee; secure letters of recommendation; and provide official transcripts of all coursework, undergraduate and graduate. Applicants for nondegree post-master's study need not take the Graduate Record Examination.

Workshops and Certificate Programs
The College of Information Science and Technology offers an array of professional development opportunities through workshops and certificate programs in various areas of library and information services and information technology.

Auditing Courses

Students who want to attend selected courses for professional development but who are not interested in graduate credit may be admitted as auditors, if space is available in the desired courses. Auditors are charged at the prevailing M.S. credit-hour rates.

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The College of Media Arts and Design

The College of Media Arts and Design offers several graduate programs in architecture, arts administration, fashion design, and interior design. The programs are distinctive in content and professionally oriented.

Graduate study in architecture is conducted full-time, but in the evenings. Study in fashion design or interior design includes two years of full-time design curricula. Students may enroll in the arts administration program on a full-time or part-time basis. Full-time arts administration students may complete the degree in one and a half years.

- Post-Professional Master of Architecture Program
- Master of Science in Arts Administration
- Master of Science in Fashion Design
- Master of Science in Interior Design

Post-Professional Master of Architecture Program

This program is for architectural professionals who seek opportunities for research, advanced design, and specialized coursework.

Many architects who hold the Bachelor of Architecture degree want to pursue post-professional studies but have been unable to do so because they cannot stop working to undertake a full-time program. Drexel's evening format solves that dilemma. It is a unique approach appropriate for a large urban area that has a strong professional community.

The scope of the architectural profession is expanding, and so is its complexity. Design solutions have become more sophisticated, using many alternative approaches rarely covered in undergraduate education. These changes include:

- *Increased concern for the environmental impact of building*
- *Concern for contextual variables*
- *A renewed interest in preservation and historical design*

The post-professional master of architecture degree lets students hone their design skills through in-depth studio experiences. Graduate courses provide specialized knowledge in areas of the profession not emphasized in undergraduate program, such as management, technology, and theory.

The profession recognizes that architects must advance their understanding, knowledge, and skills to deal with the changes affecting the profession. Lifelong learning is a part of architects' professional life. Many states and the American Institute of Architects require continuing education for architects to maintain registration or membership. Drexel's post-professional master's degree can meet those requirements while providing recipients with a stronger set of knowledge and skills than they could achieve by taking independent courses.

In many universities, a Master of Architecture degree is the minimum educational requirement to teach. Newly graduated holders of a bachelor's degree can use graduate studies to satisfy internship requirements for licensure.

The work-study approach helps to manage the costs of education. This model is also employed by other Drexel graduate programs, such as the MBA.

Finally, the Drexel program provides an opportunity to pursue graduate study without interrupting a professional career. Students typically come from Philadelphia and the surrounding area, have several years of professional experience, and hold responsible positions in their firms. International students can also pursue graduate architectural studies at Drexel.

The Program
The program requires 48 credits, consisting of a combination of graduate design studios and advanced courses and seminars.

Graduate studios offer intensive specialized investigations involving research, problem solving, theory building, and practical application. Graduate courses in three subject areas—management, history and theory, and architectural technology—let students pursue either a specialized or a general program. The department's summer study tours in Rome and Paris are also included in the graduate offerings.

This program builds upon Drexel's well-established and successful evening program, whose strength lies in its experienced and committed faculty of practicing architects who bring both practical and theoretical knowledge to the classroom. Courses utilize the assets of this practitioner-faculty as well as collaborative arrangements with other disciplines at Drexel.

To provide a broad level of criticism and instruction, two instructors staff each studio. Seminars are generally taught independently of studios, but the two can be integrated when subject matter and enrollment warrant it.

Admission Requirements

Applicants must hold a first professional degree in architecture—typically a Bachelor of Architecture degree. Applicants must also submit a portfolio of academic and professional work and a personal statement of objectives in pursuing the master's degree.

Applications from international students must meet all University admission requirements. Applicants whose native language is not English must take the Test of English as a Foreign Language (TOEFL) and achieve a minimum score of 550. International applicants must demonstrate that their degree is equivalent to an accredited Bachelor of Architecture degree.

Curriculum

Students can take the required 48 credits in one of two ways:

five studios and six courses, or four studios and eight courses. To meet the needs of working students, the program allows each student to construct a course of study that meets his or her individual needs, interests, and constraints.

Studies usually take at least two years, although some students may choose the accelerated six-quarter sequence while others may take three or more years by selecting topics of interest or adjusting their schedules to their professional commitments. International students without work commitments will typically complete the program in under two years.

Sample Regular Sequence

First Year

Fall		**Credits**
	Studio 1	6.0
	Seminar 1	3.0
Winter		
	Studio 2	6.0
	Seminar 2	3.0
Spring		
	Studio 3	6.0
	Seminar 3	3.0

Summer

	Studio 4	
or		
	Study Tour	6.0

Second Year

Fall

	Studio 5	6.0
	Seminar 4	3.0

Winter

	Seminar 5	3.0
	Seminar 6	3.0

Sample Accelerated Sequence

Fall

	Studio 1	6.0
	Seminar 1	3.0
	Seminar 2	3.0

Winter

	Studio 2	6.0
	Seminar 3	3.0
	Seminar 4	3.0

Spring

	Studio 3	6.0
	Seminar 5	3.0
	Seminar 6	3.0

Summer

	Studio 4	6.0
	Seminar 7	3.0
	Seminar 8	3.0

Studios

Master's studios propose concentrated investigations into critical areas of architecture. They incorporate research, analysis, and design and have an application or theoretical base. Studios are offered in a one-quarter or a two-quarter sequence, depending on the issues investigated. All studios meet two nights per week.

Topics are announced in advance so that students can plan their programs. Some of the topical concerns are:

- *Contemporary Design Issues: Concentrates on current theoretical issues or questions about a particular building type. Taught by senior faculty members who are well-known designers.*
- *Architecture and Technology: Includes sustainability, advanced structure, communication, construction, and energy issues in architecture. Emphasizes the integration of building systems in design.*

- *Urban Design: Investigates design issues involved in urban morphology, city and new-town design, and community development.*
- *Traditional Architecture: Includes studies in classical architecture, vernacular and traditional design, or historic preservation.*
- *Research and Design: Incorporates the findings of design research to investigate architecture and the relationship between people and their environments.*

Faculty
Unlike schools of architecture that rely on a full-time academic faculty whose members have limited involvement in the profession, Drexel's architecture faculty consists of more than 65 practicing architects, planners, and engineers. A partial list of faculty follows.

Peter Arfaa, Principal, Peter F. Arfaa, Architects; *Adjunct Professor*

Sherman Aronson, Partner, DPK&A Architects; *Adjunct Associate Professor*

Cecil Baker, Principal, Cecil Baker & Associates; *Adjunct Professor*

Judith Bing, *Associate Professor*

Andrew Blanda, Principal, Sanvold Blanda Architecture & Interiors; *Adjunct Associate Professor*

John Blatteau, Principal, John Blatteau Associates; *Adjunct Professor*

Stephen Bonitatibus, Principal, Bonitatibus Architects; *Adjunct Professor*

Mark Brack, Ph.D., *Assistant Professor*

Edwin Bronstein, Principal, Edwin Bronstein, AIA; *Adjunct Professor*

Richard Brown, Principal, Richard E. Brown Associates; *Adjunct Professor*

Michael Burns, Principal, Michael Burns Architect; *Adjunct Associate Professor*

Charles Dagit, Principal, Dagit-Saylor Architects; *Adjunct Professor*

John DeFazio, Principal, John DeFazio Architects; *Adjunct Assistant Professor*

John Dundon, *Instructor*

Steven Gatschet, Architect, School District of Philadelphia; *Adjunct Professor*

Alan Greenberger, Principal, MGA Partners; *Adjunct Professor*

David Hamme, Managing Partner, Wallace Roberts & Todd; *Adjunct Professor*

Paul M. Hirshorn, A.I.A., M.Arch., *Professor and Head of the Department*

Don Jones, Partner, Ewing Cole Cherry Brott; *Adjunct Associate Professor*

Daniel Kelley, Principal, MGA Partners; *Adjunct Professor*

Jeffrey Krieger, Principal, Krieger & Associates, Architects; *Adjunct Associate Professor*

Anish Kumar, Head of Urban Design, Hillier Architects, Philadelphia; *Adjunct Assistant Professor*

Nadir Lahiji, Ph.D., *Adjunct Professor*

Howard Lebold, Principal, McGillin Architecture, Inc.; *Adjunct Instructor*

Alina Macneal, *Adjunct Associate Professor*

Arlene Matzkin, Principal, Friday Architects/Planners, Inc.; *Adjunct Associate Professor*

Donald Matzkin, Principal, Friday Architects/Planners, Inc.; *Adjunct Professor*

Daniel McCoubrey, Director, Venturi Scott Brown Associates; *Adjunct Professor*

Lawrence McEwen, Principal, Lawrence D. McEwen, Architect; *Adjunct Assistant Professor*

Walter Moleski, B.Arch., *Instructor and Assistant Department Head*

Robert Nalls, Principal, Nalls Architecture, Inc.; *Adjunct Associate Professor*

Christopher Pastore, Ph.D. Candidate, *Adjunct Associate Professor*

Peta Raabe, Principal, Lager-Raabe Landscape Architects; *Adjunct Associate Professor*

James Rowe, Partner, Agoos/Lovera, Architects; *Adjunct Assistant Professor*

Joseph Scanlon, Associate, Ewing Cole Cherry Brott; *Adjunct Associate Professor*

Rachel Schade, Principal, Schade & Bolender, Architects; *Adjunct Associate Professor*

Jahan Sheikholeslami, Principal, JSA Architecture and Planning; *Adjunct Professor*

Simon Tickell, Associate, Bohlin Cywinski Jackson; *Adjunct Associate Professor*

Nancy Trainer, Associate, Venturi Scott Brown Associates; *Adjunct Assistant Professor*

Franca Trubiano, Ph.D. Candidate, *Adjunct Associate Professor*

Mark Ueland, Principal, Ueland Junker McCauley Nicholson; *Adjunct Professor*

Michael Ytterberg, Ph.D. Candidate and Senior Associate, Bower, Lewis, Thrower Architects; *Adjunct Associate Professor*

Master of Science in Arts Administration

Program Objective

The M.S. program in arts administration is designed to provide academic preparation for management positions with nonprofit organizations, foundations, corporations, and government agencies involved in the visual and performing arts.

General Information

In addition to meeting the general requirements for admission to graduate studies, applicants should present a résumé demonstrating a strong affinity for the field through work, volunteer experiences, education, or special training. Undergraduate preparation must include at least one course in financial accounting, two courses in the history or literature of an art, and/or two courses in the practical or creative aspects of an art. Applicants who lack this preparation (or the equivalent) must complete work in the above areas during the first two terms in the program.

An important part of the admissions process is a personal interview with the Program Director. Potential applicants are encouraged to schedule an interview through the Department of Performing Arts (215-895-2451) early in the application process.

Students may enroll in the program on a full- or part-time basis. Classes are offered in the evening. With the exception of the internship, the entire program can be completed in the evening. Students may enter the program at the start of the fall, winter, or spring term. Full-time arts administration students may complete the degree in one and a half years.

Financial Assistance

A limited number of assistantships are available. Students should indicate their interest in these positions in their initial letters of inquiry. Students are also encouraged to explore other assistantships available across the University. In the past, arts administration students have held positions in the honors program, the Greek Life Office, the Leadership Program, and the College of Evening and Professional Studies. Awards are made annually on a competitive basis.

Program Requirements

Each student selects an academic advisor, who assists with the planning and completion of a program of study in accordance with the student's needs and career goals. Each candidate for the M.S. in arts administration must complete 45 credits, including courses in cultural policy, management skills, and arts administration. To enable the student to tailor the program of study to meet his or her career goals, a variety of electives are offered. Students may identify tracks in marketing, fund development, finance, or research through their selection of electives.

Advanced students may work in an appropriate arts-related job associated with a professional arts organization. After completing all core courses and correcting any deficiencies in academic preparation, the student selects an internship coordinator from among the full-time faculty of the program. The student's thesis grows out of the internship experience or can address a research topic that the student wishes to explore further.

Graduates of the program serve in various administrative capacities with museums,

historical societies, ballet and dance companies, government agencies, symphony orchestras, and philanthropic and corporate foundations.

Curriculum

Professional requirements		Credits
AADM 505	**Overview of Arts Administration**	3.0
AADM 510	**Writing for the Arts**	3.0
AADM 610	**Financial Accounting for Nonprofit Arts Organizations**	3.0
AADM 620	**Law in the Arts**	3.0
AADM 650	**Fund Development for the Arts**	3.0
AADM 710	**Programmatic Planning and Evaluation**	3.0
AADM 750	**Arts Administration Seminar**	3.0
AADM 751	**Management Techniques in the Arts**	3.0
AADM 765	**Special Topics: Nonprofit Marketing**	3.0
AADM 770	**Technology and the Marketing of the Arts**	3.0
AADM 798	**Thesis and Internship**	3.0
	Electives	12.0

Sample elective offerings		Credits
AADM 540	**Production Procedures in the Arts**	3.0
AADM 740	**Production Laboratory in the Performing Arts**	3.0
AADM 760	**Special Problems in Arts Management**	3.0
AADM 765	**Special Topics: Community Cultural Planning**	3.0
AADM 765	**Special Topics: Leadership in the Arts**	3.0
ORGB 622	**Group and Interpersonal Behavior in Organizations**	3.0
ORGB 626	**Analysis of Complex Organizations**	3.0
ORGB 628	**Group Dynamics and Problem-Solving**	3.0
ORGB 632	**Organizational Change and Development**	3.0

Faculty Research Interests

Please note: this list of faculty applies to the master of science programs in arts administration, fashion design, and interior design.

Barry Atticks, Ph.D. *(Pennsylvania State University), Assistant Professor and Director of Music Industry*
Music technologist, pianist; music education, music industry, sound effects editing.

Elliott Barowitz, M.F.A. *(University of Cincinnati), Professor*
Painter; contemporary art history, aesthetics, problems in the art process.

Peter Bartscherer, M.S. *(Drexel University), Director of Design Arts/Computing Services*
Computer graphic design, publication management, prepress imaging.

Alfred W. Blatter, D.M.A. *(University of Illinois), Professor and Head of the Department of Performing Arts*
Music: composition, computer applications, editing, contemporary notation, concert production, theory, arranging.

Renée Weiss Chase, M.S. *(Drexel University), Professor and Director of the Fashion Design Program*
Fashion designer; computer-aided design systems for the fashion curriculum.

Carol Chew, M.S. *(Drexel University), Instructor*
Interior designer; healthcare interiors, contract design.

Sylvia Clark, M. Arch. *(University of Pennsylvania), Professor Emeritus*
Registered architect and painter; design education.

Robert Croston, M.A. *(University of Massachusetts), Associate Professor*
Industrial designer; human factors engineering, robotics, interactive computer-aided design systems.

Rena Cumby, M.S. *(Drexel University)*, B. Arch. *(Drexel University), Assistant Professor and Director of the Graduate Interior Design Program*
Interior designer; foundation studies and design education.

Eugenia Ellis, M.S. *(University of Pennsylvania), Assistant Professor*
Registered architect; interior design, extended-care facilities design, research on spatial visualization, perception and imagination.

Cecelia Fitzgibbon, M.A. *(New York University), Assistant Professor and Director of Arts Administration*
Cultural policy, managing change in arts organizations, programmatic planning and evaluation.

Joseph Grünfeld, Ph.D. *(Hebrew University, Jerusalem), Professor*
Philosopher; philosophical relationships of science, technology, aesthetics, and values.

Marilyn Hefferen, B.F.A. *(Pratt Institute), Assistant Professor*
Fashion designer; knitwear, textile design, global product development, computer graphics.

Nadine Heller, M.F.A. *(Columbia University), Associate Professor and Head of the Department of Visual Studies*
Painter; oral-visual history, media explorations, art history and cultural studies.

Roberta Hochberger-Gruber, M.S. *(Drexel University), Associate Professor and Director of Design and Merchandising*
Fashion designer and illustrator; wearable art, fashion merchandising.

Lydia Hunn, M.F.A. *(University of Pennsylvania), Associate Professor*
Performance art, installations.

Adrienne Jenkins, B.S. *(Pennsylvania State University), Senior Lecturer and Researcher*
Arts administrator; cultural policy research, community cultural planner.

Anna Kiper, B.F. A. *(Moscow College of Art and Technology), Instructor*
Fashion designer; bridal tailoring and couture design, wearable technology, fashion illustration, fashion forecasting.

Marjorie Kriebel, B. Arch. *(University of Pennsylvania), Professor and Associate Dean of the College*
Registered architect; history of modern architecture, Philadelphia interiors.

Karin Sundstedt Kuenstler, M.S. *(Bank Street College of Education and Parsons School of Design), Associate Professor and Head of the Department of Design*
Interior designer; interior design for corporate and commercial facilities, history of corporate interiors, fiber art.

Annette S. Levitt, Ph.D. *(Pennsylvania State University), Professor*
Modernism; relations among the arts, especially in 20th-century France; surrealism.

Kathi Martin, M.S.I.S. *(Drexel University), Assistant Professor and Director of the Graduate Fashion Design Program*
Fashion and textile designer; textile artist; computer-aided design, searchable online databases and graphic interfaces for fashion and historic costume, Open Archive Initiative standards.

Charles Morscheck, Jr., Ph.D. *(Bryn Mawr College), Professor*
Art historian; Renaissance art, research on Lombard sculpture and building practices.

Glen Muschio, Ph.D. *(Temple University), Assistant Professor and Director of Digital Media*
Anthropology, multimedia, social sciences, video, new media.

Keith Newhouse, M.F.A. *(Claremont Graduate School), Professor*
Sculptor; drawing, sculpture, wood furniture.

Juanita Phillips, B.S. *(Drexel University), Instructor*
Fashion designer and educator.

William Pollock, M.A. *(Villanova University), Assistant Professor*
Production designer; scenic design, lighting design, costume design, design for television and film.

Steven S. Powell, D.M.A. *(Indiana University), Associate Professor*
Choral techniques and repertoire, Renaissance and Baroque performance practices, computer-synthesizer applications, desktop publishing.

David Raizman, Ph.D. *(University of Pittsburgh), Professor and Associate Dean of the College*
Art historian; research on Spanish medieval art.

Marilynne L. Rose, M.S. *(Drexel University), Instructor*

NCIDQ interior designer; residential and commercial design.

Debra Ruben, M.S. *(Drexel University), Instructor*
Interior designer; residential design, commercial space planning.

Adelle S. Rubin, M.S. *(Temple University), Lecturer in Theater and Producer/ Director of the Drexel Players*
Theatrical production and direction.

George Starks, Ph.D. *(Wesleyan University), Professor*
World music, jazz ensembles.

Bella Veksler, M.A. *(Theatrical College of Arts and Design, Odessa, CIS), Instructor*
Fashion design, history of costume.

Brian Wagner, M.F.A. *(University of Pennsylvania), Associate Professor*
Painter and sculptor; art assessment of early American glass, patchwork quilts.

Michael Webb, M.F.A. *(Pratt Institute), Professor*
Painter; art-architectural collaborative work murals, drawing.

Dennis Will, M.F.A. *(University of Wisconsin), Professor*
Sculptor; dialogue between art and architecture, architectural and environmental scale, urban art.

Master of Science in Fashion Design

General Information

The Design Department offers a full-time, two-year design program leading to the M. S. degree in fashion design. This is a first professional degree program that stresses the development of technical skills and research and experimentation in the business of fashion design. The curriculum is organized so that studio, laboratory, and classroom work give the graduate student a directed experience in the study of aesthetics, criticism, and contemporary art concepts; contemporary and historic art and design; current technology; the discipline of drawing; and the making of art.

The goal of the M.S. program in fashion design is to integrate the understanding of design with the construction of clothing so that the final products answer physical, aesthetic, psychological, and social needs within the context of contemporary fashion and industrial limitations. This approach provides a sound basis for a broad range of employment in the fashion industry and in education. Other professional opportunities lie in merchandising, costume design, curatorial work, and computer-aided design.

The faculty of the Design Department includes art historians, CAD specialists, designers, fiber artists, painters, and sculptors. The department also draws on practicing professionals as adjunct professors for specialized coursework and for critique of student work.

A limited number of graduate assistantships are available to students after the first year.

Students are invited to participate in the activities of the Fashion Group of Philadelphia, a chapter of an international organization of professionals in the fashion industry. Students may also participate in the Student Fashion Group and attend sponsored trips to fashion events in New York City.

The Design Department produces a professionally juried annual fashion show, which provides excellent exposure for graduate students.

Facilities

Department facilities include laboratories for clothing construction and design processes and studios for fashion design, knitting, photography, painting, and computer-aided design. The history of costume is taught with primary source material from Drexel's Historic Costume Collection. The Design Gallery provides exhibition facilities for student and faculty work as well as the work of area artists and professionals.

Admission Requirements

Students enter the program from diverse backgrounds, including liberal arts, fine arts, and business. A personal interview is strongly recommended. The admission criteria for the graduate program consist of the requirements of the University for graduate admission plus satisfaction of undergraduate coursework in basic fashion design skills and concepts. These prerequisites comprise 31 credits in design, drawing, and art history in addition to 32 credits in specific undergraduate fashion design professional courses, or their equivalent.

Prerequisite undergraduate coursework		Credits
ARTH 335	**History of Costume: Preclassical–Mid-18th Century**	3.0
ARTH 336	**History of Costume: Late 18th Century–Contemporary**	3.0
FASH 201	**Survey of the Fashion Industry**	
or		
FASH 210	**Presentation Techniques in Fashion Design**	3.0
FASH 211	**Fashion Drawing I**	3.0
FASH 212	**Fashion Drawing II**	3.0
FASH 241	**Construction Skills**	4.0
FASH 251	**Fashion Design I**	4.0
FASH 341	**Flat Pattern Design**	4.0
FASH 342	**Draping Design**	4.0
FASH 343	**Tailoring and Design**	4.0
VSST 104	**Accelerated Design I***	2.0
VSST 105	**Accelerated Design II***	2.0
VSST 106	**Accelerated Design III***	2.0
VSST 110	**Introductory Drawing**	3.0
VSST 111	**Figure Drawing I**	3.0
VSST 112	**Figure Drawing II**	3.0
VSST 204	**Materials Exploration**	4.0
VSST 211	**Textiles**	3.0

Two of the following		6.0
ARTH 101	**History of Art I: Ancient to Medieval**	
ARTH 102	**History of Art II: Renaissance to Modern**	
ARTH 103	**History of Art III: Early Modern to Postmodern**	

***Or VSST 101, VSST 102, VSST 103 (Design I, II, III;12.0 credits).**

Beginning in the summer term, the department offers a four-term prerequisite year to prepare candidates for the graduate coursework. An evaluation by a graduate advisor determines what prerequisites have been satisfied. Contact the department for specific information about prerequisites or to make an appointment for evaluation.

Curriculum

The two years of full-time graduate coursework combine four terms of faculty-

directed studio work in fashion design and two terms of student-directed independent studio work with required courses in design, aesthetics, and the art process. Elective coursework in fashion or specific topics; advanced studies in art, computer-aided design, art history, and fashion design; and independent studies allow individual flexibility in curriculum design.

Fashion design studios		Credits
FASH 600	**Fashion Industry Internship**	0.0
FASH 610	**CAD for Fashion Design**	3.0
FASH 611	**Textile Design**	3.0
FASH 615	**CAD/Patternmaking**	3.0
FASH 630	**Fashion A**	3.0
FASH 631	**Fashion B**	3.0
FASH 632	**Drawing for Industry**	3.0
FASH 730	**Fashion C**	3.0
FASH 731	**Fashion D**	3.0
FASH 765	**Fashion Presentation**	3.0
FASH 766	**Fashion Business Topics**	3.0
FASH 865	**Problem in Fashion Design, Phase I**	3.0
FASH 866	**Problem in Fashion Design, Phase II**	3.0
FASH 899	**Comprehensive Examination**	0.0
VSST 799	**Design Theory**	3.0
	Electives	9.0

Graduate Review
Graduate review consists of two components: the graduate Problem in Fashion Design and the formal Graduate Review. The Problem in Fashion Design (FASH 865 and FASH 866) emphasizes the development of an original statement of

design intent and allows the student to synthesize his or her academic experiences and prepare for the marketplace. The formal Graduate Review is a review by the graduate faculty of a portfolio presentation of a body of selected work.

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Barry Atticks, Ph.D. *(Pennsylvania State University), Assistant Professor and Director of Music Industry*
Music technologist, pianist; music education, music industry, sound effects editing.

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Painter; contemporary art history, aesthetics, problems in the art process.

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Fashion designer; computer-aided design systems for the fashion curriculum.

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Industrial designer; human factors engineering, robotics, interactive computer-aided design systems.

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Interior designer; foundation studies and design education.

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Registered architect; interior design, extended-care facilities design, research on spatial visualization, perception and imagination.

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Cultural policy, managing change in arts organizations, programmatic planning and evaluation.

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Fashion designer; knitwear, textile design, global product development, computer graphics.

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Painter; oral-visual history, media explorations, art history and cultural studies.

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Fashion designer and illustrator; wearable art, fashion merchandising.

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Performance art, installations.

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Arts administrator; cultural policy research, community cultural planner.

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Fashion designer; bridal tailoring and couture design, wearable technology, fashion illustration, fashion forecasting.

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Registered architect; history of modern architecture, Philadelphia interiors.

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Sculptor; drawing, sculpture, wood furniture.

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Fashion designer and educator.

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Production designer; scenic design, lighting design, costume design, design for television and film.

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Choral techniques and repertoire, Renaissance and Baroque performance practices, computer-synthesizer applications, desktop publishing.

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Art historian; research on Spanish medieval art.

Marilynne L. Rose, M.S. *(Drexel University), Instructor*
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Interior designer; residential design, commercial space planning.

Adelle S. Rubin, M.S. *(Temple University), Lecturer in Theater and Producer/ Director of the Drexel Players*
Theatrical production and direction.

George Starks, Ph.D. *(Wesleyan University), Professor*
World music, jazz ensembles.

Bella Veksler, M.A. *(Theatrical College of Arts and Design, Odessa, CIS), Instructor*
Fashion design, history of costume.

Master of Science in Interior Design

General Information
The M.S. program in interior design is a first professional degree program. The goal of the program is to prepare students with diverse undergraduate backgrounds to enter the field of interior design, encompassing public, commercial, and institutional spaces; offices; and residences. Program faculty includes architects, art historians, graphic designers, interior designers, painters, photographers, and sculptors. The department also draws on practicing professionals as adjunct professors for specialized coursework and for critique of student work.

Student Background
The diversity of students in the program demonstrates its appeal and international reputation. Students enter the interior design program from diverse backgrounds, including liberal arts, fine arts, architecture, business, and science. Many candidates making a career change to interior design do so several years after receiving their baccalaureate degrees and after gaining experience in their original professions. Entering students are committed to intensive exploration of design in general and interior design specifically.

Professional Opportunities
Alumni are principals of their own interior design firms, project managers in major design and architectural firms, facilities managers, and design coordinators. About one-third of the students obtain entry-level employment before graduation from the program; within five years, many hold managerial positions.

Professional exposure occurs in exchanges with practitioners through professional jurying of all major student projects. Students are also encouraged to become members of local, national, and international interior design professional organizations. All interior design students are eligible to join the Drexel Interiors Group.

A limited number of graduate assistantships are available to students after the first year.

Facilities
Facilities include interior design studios, an interior design resource library, a professionally operated woodshop, photography laboratories, painting/sculpture studios, and computer laboratories. The Design Arts Gallery provides exhibition facilities for student and faculty work as well as the work of area artists and professionals.

Philadelphia, one of the nation’s major design centers, gives interior design students the vitality of the contemporary arts at local galleries; easy access to many museums, libraries, renowned buildings, and interior spaces; and access to the resources of The Marketplace, the interior design center for the mid-eastern seaboard, and of New York City.

Admission Requirements
Admission criteria for the graduate program consist of the requirements of the

University for graduate admission plus satisfaction of basic interior design undergraduate coursework. These prerequisites include courses in design, drawing, and art history in addition to courses in basic interior design professional concepts and skills. See the undergraduate catalog for course descriptions.

Prerequisite undergraduate coursework		Credits
ARTH 101	**History of Art I: Ancient to Medieval**	3.0
ARTH 102	**History of Art II: Renaissance to Modern**	3.0
ARTH 330	**History of Interior Space and Furnishings**	3.0
INTR 200	**History of Modern Architecture**	3.0
INTR 220	**Orthographic Drawing**	3.0
INTR 231	**Structure**	4.0
INTR 232	**Interior Studio I**	4.0
INTR 233	**Interior Studio II**	4.0
INTR 241	**Perspective Drawing II**	3.0
INTR 245	**CAD for Interior Design**	3.0
INTR 250	**Interior Materials**	3.0
INTR 251	**Interior Systems**	3.0
VSST 104	**Accelerated Design I***	2.0
VSST 105	**Accelerated Design II***	2.0
VSST 106	**Accelerated Design III***	2.0
VSST 110	**Introductory Drawing**	3.0
VSST 119	**Drawing for Interior Design**	3.0
VSST 211	**Textiles**	3.0

***Or VSST 101, VSST 102, VSST 103 (Design I, II, III; 12.0 credits).**

Beginning in the summer term, the department offers a four-term prerequisite year to prepare candidates for the graduate coursework. A portfolio review or evaluation by the director of the interior design program determines what prerequisites have been satisfied. Contact the department for specific information about prerequisites or to make an appointment for review and evaluation.

Curriculum

The two years of full-time graduate coursework combine four terms of faculty-directed studio work in interior design and two terms of student-initiated thesis with required courses in design, aesthetics, and the art process. More than one-fourth of the 45 credits that make up the graduate requirement are in elective coursework: interior design seminars on specific topics; advanced studies in art, art history, and interior design; and independent studies. This allows individual flexibility in curriculum design.

Required courses		Credits
INTR 631	**Interior Studio B**	3.0
INTR 730	**Interior Studio C**	3.0
INTR 731	**Interior Studio D**	3.0
INTR 799	**Special Topics (studio)**	3.0
INTR 897	**Problem in Interior Design, Phase I**	3.0
INTR 898	**Problem in Interior Design, Phase II**	3.0
INTR 899	**Comprehensive Examination***	0.0
VSST 501	**Problems of Aesthetics, Art History, and Criticism**	3.0
VSST 502	**Problems in the Art Process**	3.0
VSST 503	**Sculpture**	3.0

Electives from the following	18.0
Interior design seminars	
INTR 799 **Special Topics in Interior Design**	
INTR 860 **Advanced Independent Study in Interior Design**	

***INTR 899 consists of two components: a series of sketch problems and design competitions that must be completed during the two graduate years and faculty review of a portfolio presentation of a body of student-selected work.**

Please note: this list of faculty applies to the master of science programs in arts administration, fashion design, and interior design.

Barry Atticks, Ph.D. *(Pennsylvania State University), Assistant Professor and Director of Music Industry*
Music technologist, pianist; music education, music industry, sound effects editing.

Elliott Barowitz, M.F.A. *(University of Cincinnati), Professor*
Painter; contemporary art history, aesthetics, problems in the art process.

Peter Bartscherer, M.S. *(Drexel University), Director of Design Arts/Computing Services*
Computer graphic design, publication management, prepress imaging.

Alfred W. Blatter, D.M.A. *(University of Illinois), Professor and Head of the Department of Performing Arts*
Music: composition, computer applications, editing, contemporary notation, concert production, theory, arranging.

Renée Weiss Chase, M.S. *(Drexel University), Professor and Director of the Fashion Design Program*
Fashion designer; computer-aided design systems for the fashion curriculum.

Carol Chew, M.S. *(Drexel University), Instructor*
Interior designer; healthcare interiors, contract design.

Sylvia Clark, M. Arch. *(University of Pennsylvania), Professor Emeritus*
Registered architect and painter; design education.

Robert Croston, M.A. *(University of Massachusetts), Associate Professor*
Industrial designer; human factors engineering, robotics, interactive computer-aided design systems.

Rena Cumby, M.S. *(Drexel University)*, B. Arch. *(Drexel University), Assistant Professor and Director of the Graduate Interior Design Program*
Interior designer; foundation studies and design education.

Eugenia Ellis, M.S. *(University of Pennsylvania), Assistant Professor*
Registered architect; interior design, extended-care facilities design, research on spatial visualization, perception and imagination.

Cecelia Fitzgibbon, M.A. *(New York University), Assistant Professor and Director of Arts Administration*
Cultural policy, managing change in arts organizations, programmatic planning and evaluation.

Joseph Grünfeld, Ph.D. *(Hebrew University, Jerusalem), Professor*
Philosopher; philosophical relationships of science, technology, aesthetics, and values.

Marilyn Hefferen, B.F.A. *(Pratt Institute), Assistant Professor*
Fashion designer; knitwear, textile design, global product development, computer graphics.

Nadine Heller, M.F.A. *(Columbia University), Associate Professor and Head of the Department of Visual Studies*
Painter; oral-visual history, media explorations, art history and cultural studies.

Roberta Hochberger-Gruber, M.S. *(Drexel University), Associate Professor and Director of Design and Merchandising*
Fashion designer and illustrator; wearable art, fashion merchandising.

Lydia Hunn, M.F.A. *(University of Pennsylvania), Associate Professor*
Performance art, installations.

Adrienne Jenkins, B.S. *(Pennsylvania State University), Senior Lecturer and Researcher*|Arts administrator; cultural policy research, community cultural planner.

Anna Kiper, B.F. A. *(Moscow College of Art and Technology), Instructor*
Fashion designer; bridal tailoring and couture design, wearable technology, fashion illustration, fashion forecasting.

Marjorie Kriebel, B. Arch. *(University of Pennsylvania), Professor and Associate Dean of the College*
Registered architect; history of modern architecture, Philadelphia interiors.

Karin Sundstedt Kuenstler, M.S. *(Bank Street College of Education and Parsons School of Design), Associate Professor and Head of the Department of Design*
Interior designer; interior design for corporate and commercial facilities, history of corporate interiors, fiber art.

Annette S. Levitt, Ph.D. *(Pennsylvania State University), Professor*
Modernism; relations among the arts, especially in 20th-century France; surrealism.

Kathi Martin, M.S.I.S. *(Drexel University), Assistant Professor and Director of the Graduate Fashion Design Program*
Fashion and textile designer; textile artist; computer-aided design, searchable online databases and graphic interfaces for fashion and historic costume, Open Archive Initiative standards.

Charles Morscheck, Jr., Ph.D. *(Bryn Mawr College), Professor*
Art historian; Renaissance art, research on Lombard sculpture and building practices.

Glen Muschio, Ph.D. *(Temple University), Assistant Professor and Director of Digital Media*
Anthropology, multimedia, social sciences, video, new media.

Keith Newhouse, M.F.A. *(Claremont Graduate School), Professor*
Sculptor; drawing, sculpture, wood furniture.

Juanita Phillips, B.S. *(Drexel University), Instructor*
Fashion designer and educator.

William Pollock, M.A. *(Villanova University), Assistant Professor*
Production designer; scenic design, lighting design, costume design, design for television and film.

Steven S. Powell, D.M.A. *(Indiana University), Associate Professor*
Choral techniques and repertoire, Renaissance and Baroque performance practices, computer-synthesizer applications, desktop publishing.

David Raizman, Ph.D. *(University of Pittsburgh), Professor and Associate Dean of the College*
Art historian; research on Spanish medieval art.

Marilynne L. Rose, M.S. *(Drexel University), Instructor*
NCIDQ interior designer; residential and commercial design.

Debra Ruben, M.S. *(Drexel University), Instructor*
Interior designer; residential design, commercial space planning.

Adelle S. Rubin, M.S. *(Temple University), Lecturer in Theater and Producer/ Director of the Drexel Players*
Theatrical production and direction.

George Starks, Ph.D. *(Wesleyan University), Professor*
World music, jazz ensembles.

Bella Veksler, M.A. *(Theatrical College of Arts and Design, Odessa, CIS), Instructor*
Fashion design, history of costume.

Brian Wagner, M.F.A. *(University of Pennsylvania), Associate Professor*
Painter and sculptor; art assessment of early American glass, patchwork quilts.

Michael Webb, M.F.A. *(Pratt Institute), Professor*
Painter; art-architectural collaborative work murals, drawing.

Dennis Will, M.F.A. *(University of Wisconsin), Professor*
Sculptor; dialogue between art and architecture, architectural and environmental scale, urban art.

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The College of Nursing and Health Professions

The College of Nursing and Health Professions offers the following programs:

- Clinical Psychology
- Couple and Family Therapy
- Creative Arts in Therapy, which includes:
  - Art Therapy
  - Dance/Movement Therapy
  - Music Therapy
- Emergency and Public Safety Services
- Law/Psychology
- Nursing
- Physical Therapy
- Physician Assistant Studies
  - Entry-Level Physician Assistant Program
  - Advanced Physician Assistant Program

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Clinical Psychology

Master's Degree Program
The master's degree program in the Department of Clinical and Health Psychology is a full-time program encompassing two years of study. It provides graduate students with a strong foundation in cognitive-behavioral psychological theory, experience in the practice of psychological assessment and intervention, and experience in the conduct of basic and applied research relevant to clinical psychology.

The program prepares students to function as scientist-practitioners. Both an M.A. and an M.S. degree are offered. The M.A. program is designed for students who want to work in clinical settings under the supervision of a licensed, doctoral-level psychologist. The M.S. program is designed for students who want to work in a research setting. Students considering further education (Ph.D. or Psy.D.) can pursue either master's degree.

The Department of Clinical and Health Psychology has approximately 12 full-time faculty members. Approximately 25 students are enrolled in the master's degree program. The average class size is approximately 15, with a range from four (in small seminars) to 40.

Curriculum
The curriculum has been designed to give students a wide-based educational experience to prepare them to work in clinical settings, using a scientifically derived theory to drive their work. The curriculum provides a balance of scientific and theoretical coursework, clinically focused coursework, and practical clinical experiences.

The coursework provides training in the theory and science of cognitive-behavioral psychology. Courses are taught with a focus on the clinical relevance of the topics being addressed. They generally involve consideration of clinical issues within the framework of the course topic; many courses make clinical experience a requirement.

The program is a 48-semester-hour program, including 42 semester hours of coursework, 2 semester hours of practicum seminar, and 4 semester hours of thesis research. Emphasis is placed on developing an understanding of cognitive-behavioral treatment of various disorders, through both coursework and practicum experiences.

Students enroll in four courses during each semester of the first year. During the second semester of the first year, each student is required to complete a four-hour-per-week practicum.

In the second year, each student enrolls in three classes per semester. Students also participate in a clinical practicum throughout the second year and complete a thesis.

Students work on a wide range of research topics, including cognitive functioning, cognitive assessment, developmental disabilities, child psychopathology, chronic psychological disorders, and aggression.

In addition to coursework, practica, and thesis, master's students are required to satisfactorily pass the comprehensive examination.

Doctoral Program

The Ph.D. in clinical psychology is housed in the Department of Clinical and Health Psychology. The program is fully accredited by the American Psychological Association (APA). It encompasses five years of full-time study and provides graduate students with a strong foundation in relevant psychological theory, experience in the practice of psychological assessment and intervention, and experience in conducting meaningful clinical research.

The faculty's mission is to facilitate students' competence and skills to conduct independent research and to engage in clinical-practice activities after completing the program. After completing the coursework and varied practicum and research experiences, students are well prepared to contribute to both the profession of psychology and society at large.

Program Objectives

Drexel University's Clinical Psychology program is based on a scientist-practitioner model of training (the Boulder model) and places equal emphasis on research and clinical skills. Our faculty's research and clinical expertise includes clinical psychology, health psychology, neuropsychology, and forensic psychology. Most faculty members adhere to social learning theory and rely on this framework in their teaching, research, and clinical work.

Because our program is located in a large health sciences university, it offers unparalleled research and clinical opportunities in various subfields of health psychology and neuropsychology. One important principle within both clinical and health psychology is empiricism, which emphasizes scientific data as the foundation of clinical and research endeavors. Students also gain familiarity with alternative theoretical approaches (e.g., psychodynamic and family systems) in their coursework and practicum placements.

In addition to the Ph.D. program in clinical psychology, the Department of Clinical and Health Psychology offers the Law-Psychology program (joint J.D./Ph.D. degree program in affiliation with nearby Villanova University Law School). Approximately 100 students are enrolled in the Ph.D. program.

Curriculum

The program is designed to be completed in five years. During the first four years, students complete required courses, electives, research projects, and clinical practica. During the fifth year, students complete a full-time one-year internship program in clinical psychology, usually at another institution. After students complete all requirements through the second year, they are awarded a Master of Arts in clinical psychology.

The course curriculum is designed to meet APA requirements concerning a broad-based education in psychology, provide substantial didactic instruction in clinical and research/statistical areas, and engender an appreciation of and sensitivity to the concept of human diversity.

Research Apprenticeship

Throughout the first three years, each student serves as a research assistant to a psychology faculty member for the equivalent of one day per week (i.e., eight hours).

The purpose of the practicum is to provide an apprenticeship focusing on research. Faculty members provide hands-on experience in the conduct of clinical research and function as research mentors.

Students enter the Ph.D. program specifically to work with a faculty member whose interests match their own. Research practica are done with the student's faculty mentor.

Clinical Practica

Students are required to complete clinical practica during their second and third years. A fourth-year clinical practicum is optional. In these practicum placements, students gain important practical experience under appropriate supervision in psychological assessment, testing, and psychotherapy with individuals and groups in sites both on and off campus. During the second year, the practicum is one day per week; during the third year, it is two days per week. Assignments are made by the practicum coordinator, who attempts to match each student's interest with the needs of a particular site.

During the second and third years, students attend seminars focusing on general clinical and professional issues. Clinical supervision is provided by staff and faculty at the specific practicum facility and by members of the core faculty of the Ph.D. program.

Neuropsychology Track

The neuropsychology subspecialty track offers a full complement of coursework, clinical practica, and research experiences in clinical neuropsychology, including assessment of brain injuries, psychological assessment of and intervention in medically related disorders, and rehabilitation. The track offers a combination of coursework with intensive clinical practica in medical settings. Several interdepartmental seminars, lectures, and additional didactic courses are available.

Students accepted into this track are responsible for all coursework and practica required by the overall clinical psychology doctoral program. Rather than choosing from among the array of electives offered in the general track, these students register for additional neuropsychology-related courses (e.g., neuropsychological assessment, advanced seminar in clinical neuropsychology, and medical neuroscience).

Students typically complete one or more practica in a neuropsychology setting. Research may also focus on neuropsychology-related areas. Two students are accepted from each incoming doctoral class of 15 for the subspecialization in clinical neuropsychology. Individuals interested in being accepted into this track are required to indicate their choice when applying to the Ph.D. program.

Law-Psychology Program

Drexel collaborates with Villanova School of Law in offering the joint J.D.-Ph.D. degree in law and psychology. This is a seven-year full-time program that focuses on interdisciplinary research and scholarship, policy and legal decision-making, and the practice of both forensic psychology and mental health law.

All requirements for the Ph.D. in clinical psychology are as described earlier for the Ph.D. program. Students must also meet the requirements for the J.D. program,

but some courses are cross-listed, which reduces the duration of the program from eight years to seven. (Summers are not included during these years; most law-psychology students choose to work in positions involving relevant research or practice with law firms, the FBI, ongoing faculty projects, and many other possibilities.)

The Law-Psychology program page contains additional details about the program.

Faculty

Donald N. Bersoff, Ph.D. *(New York University), J.D. (Yale University Law School), Professor; Director of the J.D.-Ph.D. Program in Law and Psychology (joint program of Villanova University and Drexel University).* Research interests: Social science applications to law; legal regulation of psychology; mental health policy; forensic assessment; professional ethics.

Pamela Geller, Ph.D. *(Kent State University), Assistant Professor; Director of the Student Counseling Center.* Research interests: Epidemiology of mental disorders; gender issues.

Naomi E. Goldstein, Ph.D. *(University of Massachusetts), Assistant Professor.* Research interests: Mental health and the law; forensic assessment; research methods.

Julie Landel Graham, Ph.D. *(University of Miami), Assistant Professor.* Research interests: Child clinical psychology; health psychology; biobehavioral models of insulin-dependent diabetes.

Kirk S. Heilbrun, Ph.D. *(University of Texas, Austin), Professor and Chair.* Research interests: Mental health and the law; forensic assessment; community treatment of mentally ill offenders; competence to stand trial.

James D. Herbert, Ph.D. *(University of North Carolina at Greensboro), Associate Professor.* Research interests: Behavioral assessment and cognitive behavioral treatment of social phobia in adults and adolescents; psychopharmacology; psychotherapy outcome; developmental psychopathology.

Michael R. Lowe, Ph.D. *(Boston College), Professor.* Research interests: The psychobiology of eating and weight regulation, including behavioral and psychological effects of dieting, the role of dieting in eating disorders and obesity, and cognitive-behavioral treatment of eating disorders and obesity; integration of social and clinical psychology; psychotherapy integration.

Arthur M. Nezu, Ph.D. *(State University of New York at Stony Brook), Professor (joint appointments in the College of Medicine and the School of Public Health); Co-Director of the Center for Mind/Body Studies; Co-Director of Project STOP (assessment and treatment of sex offenders); Director of Project Challenge (assessment and treatment of persons with mental retardation and concomitant psychopathology); Co-Director of Cancer Control, Prevention, and Psychosocial Research at the University Cancer Center; President of the Association for the Advancement of Behavior Therapy; Fellow of the American Psychological Association and of the Society of Behavioral Medicine.* Research interests: Health psychology (coping with chronic illness, stress management, psychosocial oncology); sexual aggression and violence; clinical decision-making; cognitive-behavior therapy for depression.

Christine M. Nezu, Ph.D., ABPP *(Fairleigh Dickinson University), Professor; Director of the Center for Mind/Body Studies; Director of Project STOP (assessment and treatment of sex offenders); Co-Director of Project Challenge (assessment and treatment of persons with mental retardation and concomitant psychopathology).* Research interests: Behavioral assessment; behavioral medicine; sexual aggression and violence; dual diagnosis; coping with chronic and terminal illness; depression; integrative psychotherapy; clinical decision-making.

Catherine Panzarella, Ph.D. *(Temple University), Assistant Professor.* Research interests: Cognitive-behavioral therapy; interpersonal contributions to mental and physical health; serious mental illness (depression and bipolar disorder); treatment and etiology of depression; assessing depression in primary-care settings; coping among cardiac patients and their partners.

Myrna B. Shure, Ph.D. *(Cornell University), Research Professor.* Research interests: Prevention of psychopathology; social-cognitive development of social competence; interpersonal cognitive problem-solving skills.

J. Michael Williams, Ph.D. *(University of Vermont), Associate Professor.* Research interests: Early cognitive sequelae of traumatic brain injury; clinical neuropsychological assessment; cognitive neuropsychology; rehabilitation.

Program Facilities

Computers

Computer resources for student use include more than 20 personal computers (IBM, Macintosh) available in the library and 10 IBM PCs available in the computer laboratory. Both facilities are near the department. In both locations, word processing and biostatistics software is available.

By using computers from their homes or in the library, students have free access to e-mail and a wide array of online services (e.g., the Internet, World Wide Web, and literature databases such as PsychLit and Medline).

Library

Psychology books and journals are located at the Center City Hahnemann Campus library and the Eastern Pennsylvania Psychiatric Institute (EPPI) library on the Henry Avenue MCP Campus. The combined holdings represent one of the best psychology libraries on the East Coast.

Equipment

Testing equipment for classroom instruction is available to psychology graduate students. The program also has videotape and audiotape equipment available for classroom instruction and research activities.

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Couple and Family Therapy

Master's Program
Drexel University offers a two-year program in couple and family therapy leading to the Master of Family Therapy (M.F.T.) degree. The program is accredited by the Commission on Accreditation for Marriage and Family Therapy Education (COAMFTE) of the American Association for Marriage and Family Therapy (AAMFT).

The program prepares students for the profession of couple and family therapy through academic and clinical training. It exposes students to broad areas of theory and practice and provides an intensive, supervised clinical experience. The program emphasizes the interdependence of individual experience and the relational context, extending from family of origin (including traditional and nontraditional families) to the global community. The program is committed to training students to be aware of and sensitive to cultural diversity. In addition, the person of the therapist, including the student's own culture, is a major aspect of the clinical training. Class sizes average 15 students.

Drexel is located in an urban environment. Students have the opportunity to interact with a diverse client population and address a wide variety of clinical issues.

Curriculum
The curriculum assists students in integrating theory and practice. Issues of race, class, gender, sexual orientation, and ethnicity are addressed throughout the program. Students are fully trained to assume clinical practice in couple and family therapy and are prepared for associate membership in the AAMFT. The educational and training experience has six major components:

- *The historical development of systems theory and cybernetics and the use of the systems paradigm in treatment*
- *A comprehensive survey of major models of change in marriage and family therapy, with an emphasis on assessment and treatment*
- *Conceptual understanding of complex relational dynamics across the family life cycle, with a focus on such contexts as race, class, gender, sexual orientation, and ethnicity*
- *Ethical, legal, and professional responsibilities of marriage and family therapists*
- *Quantitative and qualitative research in marriage and family therapy*
- *Supervised clinical practica, in which students receive a minimum of 100 hours of individual and group supervision (at least 50 percent of supervision must be based on raw data) and a minimum of 500 hours of face-to-face client contact (at least 250 client contact hours must be relational)*

The program teaches several major schools of thought, including Bowenian, contextual, object relations, strategic, postmodernism, and structural.

Doctoral Program

The Ph.D. program in Couple and Family Therapy (CFT) holds candidacy status with the Commission on Accreditation for Marriage and Family Therapy Education (COAMFTE). The program is designed to prepare scientists-practitioners who are dedicated and trained to advance the knowledge base of couple and family therapy through education, research, and clinical services.

The program is rooted in systems theory and therapy. Emphasis is on specialized training in couple and family therapy theory and technique. Students are expected to demonstrate critical and analytical thinking with respect to the broad areas of systems theory and therapy, and to articulate their own theoretical approach to couple and family therapy. The program is committed to training students to be aware of and sensitive to such contextual issues as race, class, gender, and sexual orientation as well as the person of the therapist. The average class size is eight students, and the program has a ratio of six students per faculty member.

Curriculum
Students are required to complete the standard curriculum in couple and family therapy before pursuing the doctoral curriculum. The standard curriculum is offered in the COAMFTE-accredited Master of Family Therapy program at the University. A minimum of 72 post-master's semester hours are required for the Ph. D. program.

The curriculum includes study in the following areas:

- *Theory and research in couple and family therapy*
- *Research methodology, including statistics, research design, and computer applications*
- *Specialized instruction in couple and family therapy*
- *Domestic violence, school-based settings, diverse family structures, and forensic family therapy*
- *Supervised clinical experience*
- *Supervision of supervision*

Clinical Training
Students must be actively engaged in clinical practice throughout the program. After completing the majority of coursework, they are required to do a clinical internship. The internship must be 9 to 12 months long and at least 30 hours per week. During the clinical internship, students must obtain a minimum of 500 direct client contact hours (250 of the 500 hours must be with couples and/or families) and a minimum of 100 hours of supervision. Individual and group supervision is required. At least 50 of the 100 hours of supervision must be based on raw data (live observation and/or videotapes).

Clinical internships are arranged by the students and approved by the program. They may be national or international, provided that they meet program standards. Local clinical internships include Philadelphia prisons, family court, mental health agencies, outpatient psychiatry and substance abuse facilities, and private group practice.

Faculty
Stephanie Brooks, M.S.W. *(University of Pennsylvania), Assistant Professor and Associate Director*

Eric Johnson, Ph.D. *(Rutgers University), Assistant Professor*

John Lawless, Ph.D. *(University of Pennsylvania), Assistant Professor*

Cheryl Litzke, M.F.T. *(Hahnemann University), Assistant Professor*

Marlene F. Watson, Ph.D. *(Virginia Polytechnic Institute and State University), Associate Professor and Director*

Adjunct Faculty

Harry J. Aponte, L.S.W. *(Fordham School of Social Work)*

Catherine Ducommun-Nagy, M.D. *(University of Lausanne, Switzerland)*

Vincent J. Gioe, Ph.D. *(Temple University)*

Richard B. McCune, D.Min. *(Andover Newton Theological School)*

Edward Monte, Ph.D. *(University of Waterloo, Ontario)*

William Silver, D.S.W. *(University of Pennsylvania)*

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Creative Arts in Therapy

The Creative Arts in Therapy program is based on specialized didactic and clinical education in art therapy, dance/movement therapy, and music therapy. (See the following pages for specific program information for each of these options.) The curriculum includes core courses in areas related to mental health sciences, theory of human development and human behavior, theory of creative arts in therapy, research, and ethics, and specialized courses for students of each arts therapy modality. Students receive approximately 1,200 hours of supervised practica and internship in a variety of medical, psychiatric, and educational settings with children and adults.

The two-year program offers the Master of Arts degree and leads to eligibility to take board certification exams and/or registration in art, dance/movement, or music therapy. Part-time study is available.

Core Curriculum

All students in the program take the core courses, which are described here. Students in all three arts therapy modalities take core courses together. This core curriculum provides a theoretical and clinical foundation on which art, dance/movement, and music therapy are based. Students also take courses in their specialties, which are described later in this catalog.

First Year

Requirements		Credits
ARTS 509	**Normal and Abnormal Psychological Development**	1
ARTS 515	**Clinical Diagnosis of Psychopathology I**	1
ARTS 516	**Clinical Diagnosis of Psychopathology II**	1
ARTS 522	**Ego and Character**	1
ARTS 541	**Creative Arts in Therapy Workshop I**	1
ARTS 542	**Creative Arts in Therapy Workshop II**	1
ARTS 710	**Child Therapy Case Presentation**	1
ARTS 711	**Adult Therapy Case Presentation**	1
ARTS 722	**Group Dynamics Theory**	1
ARTS 730	**Creative Arts in Therapy Literature Seminar I**	1
ARTS 731	**Creative Arts in Therapy Literature Seminar II**	1
ARTS 743	**Introduction to Behavioral Research for Creative Arts Therapists**	2

ARTS 830	**Mental Health Science Supervision I**	1
ARTS 831	**Mental Health Science Supervision II**	1

Second Year

Requirements		Credits
ARTS 580	**Introduction to Family Therapy for Creative Arts Therapists**	2
ARTS 702	**Applied Ethics for the Creative Arts Therapies**	1
ARTS 744	**Group Dynamics Seminar**	1
ARTS 747	**Theories in Psychotherapy I**	1
ARTS 748	**Theories in Psychotherapy II**	1
ARTS 851	**Advanced Mental Health Science Supervision I**	1
ARTS 857	**Advanced Mental Health Science Supervision II**	1
	Core credits	23

Electives		Credits
ARTS 560	**Introduction to Arts Medicine**	1
ARTS 729	**Introduction to Jungian Psychology for Creative Arts Therapists**	2
ARTS 750	**Introduction to Hypnosis for Creative Arts Therapists**	2

Note: Please refer to the sections on the three Creative Arts in Therapy specialties for additional course requirements.

Creative Arts in Therapy Faculty

Steven Adelman, Ph.D., *Adjunct Senior Instructor*

Jean Barr, M.S.W., *Adjunct Associate Professor*

Frances Bonds-White, Ed.D., *Adjunct Associate Professor*

Gayle L. Gates, M.A., ADTR, *Clinical Assistant Professor and Associate Director, Dance/Movement Therapy Education*

Nancy Gerber, M.S., A.T.R.-B.C., *Associate Professor and Director of Art Therapy Education*

Ernest Glazer, M.S.W., *Adjunct Senior Instructor*

Sharon W. Goodill, M.C.A.T., ADTR, *Associate Professor and Director, Dance/Movement Therapy Education*

Ronald E. Hays, M.S., A.T.R.-B.C., *Associate Professor and Director, Creative Arts in Therapy Education Program*

Lauren Katz, M.D., *Adjunct Assistant Professor*

Art Therapy Program

The Art Therapy program was founded in 1967 at Hahnemann Medical College and Hospital. It was the first program in the world to offer graduate-level art therapy education, and it continues to be one of only a few housed in an academic health center. In addition to the academic curriculum, an affiliation with the Pennsylvania Academy of the Fine Arts lets students use free art studio space.

In keeping with its long tradition, the program offers an innovative curriculum. Art psychotherapy and creativity are integrated with current theoretical and practical approaches to assessment and treatment in such fields as mental health, medicine, public health, and education. Didactic, clinical, experiential, and supervisory aspects of the program are balanced and integrated to provide a foundation of theoretical knowledge, personal growth, and practical application. There are also specialty tracks in medical art therapy, forensic art therapy, and education-based art therapy.

Faculty members have credentials, interest, and expertise in both the arts and therapy. They provide students with rich and creative learning experiences that are instrumental in helping students synthesize the principles of art therapy with those of mental health, medicine, education, public health, and other fields where art therapy might be beneficial.

The Art Therapy program has been approved by the American Art Therapy Association since 1979, and received its most recent reapproval in 1997.

Curriculum
The art therapy curriculum synthesizes multiple educational components. Its content and teaching methods form a rich interwoven texture integrating specialized and interdisciplinary learning. The careful juxtaposition of theory, clinical practice, experiential self-exploration through art-making, supervision, research, and professional development provides a dynamic interactive environment in which students develop the skills, knowledge, and maturity to become art therapists.

The curriculum integrates core courses with the specialty art therapy courses. Core courses focus on human development, psychopathology, group dynamics, models of therapy, creativity, and clinical articulation skills through case presentation. The art therapy courses and clinical experiences teach students specific applications using art therapy theory and practice. By integrating core courses with the art therapy courses, students learn alongside other creative arts therapists and learn from psychiatrists and psychologists as well as art therapists. This enhances their knowledge and their ability to communicate with other professionals. They are also able to establish their identity as art therapists who work as members of a creative and dynamic team.

The program contains a strong research component. Each student is required to conduct original research, culminating in the writing of a master's thesis. The research is under the guidance of the student's advisor and is based on the student's interests and the research needs of the profession. Conducted during the second year of study, the research project stresses the development of skills in the production and consumption of research. In combination with a second-year internship of the student's choice, the research encourages specialization in a

particular area of practice in art therapy.

At an annual research colloquium, co-sponsored by Drexel University and the Delaware Valley Art Therapy Association, graduating art therapy students present their original research as a way of marking their entry into the profession. Students and graduates also present poster sessions at the American Art Therapy Association annual conference and at a University-sponsored research day.

The program contains 60-plus credits, which meets most state licensure requirements. Its 1,200 clinical hours exceed the clinical practicum requirements of the American Art Therapy Association.

Art Therapy Courses

First Year

Requirements		Credits
ARTS 531	**Art Therapy Skills—Adult I**	1
ARTS 532	**Art Therapy Skills—Adult II**	1
ARTS 535	**Art Therapy Skills—Children I**	1
ARTS 536	**Art Therapy Skills—Children II**	1
ARTS 555	**Special Art Therapy Literature**	1
ARTS 556	**Theory and Art Therapy Symbolism I**	1
ARTS 557	**Theory and Art Therapy Symbolism II**	1
ARTS 600	**Art Therapy Thesis Research I**	1
ARTS 766	**Art Therapy Clinical Practicum I**	1
ARTS 768	**Art Therapy Clinical Practicum II**	1
ARTS 833	**Art Therapy Group Supervision I**	1
ARTS 834	**Art Therapy Group Supervision II**	1

Second Year

Requirements		Credits
ARTS 591	**Family Art Therapy Assessment**	1
ARTS 601	**Art Therapy Thesis Research II**	2
ARTS 602	**Art Therapy Thesis Research III**	2
ARTS 724	**Group Art Therapy**	1
ARTS 738	**Art Therapy Literature Seminar**	1
ARTS 755	**Art Therapy Workshop**	1
ARTS 783	**Advanced Skills in Art Therapy I**	1
ARTS 784	**Advanced Skills in Art Therapy II**	1
ARTS 790	**Art Therapy Clinical Internship I**	3-6
ARTS 791	**Art Therapy Clinical Internship II**	3-6
ARTS 841	**Advanced Art Therapy Group Supervision I**	1
ARTS 842	**Advanced Art Therapy Group Supervision II**	1

Electives		Credits
ARTS 751	**Pediatric Medical Art Therapy**	1
ARTS 752	**Adult Medical Art Therapy**	1
ARTS 753	**Forensic Art Therapy**	1
ARTS 792	**Art Therapy in Educational Settings**	1

Note: Please refer to general Creative Arts in Therapy for core course requirements.

Art Therapy Faculty

Suzanne Bolger, M.A., A.T.R. *(Hahnemann University)*; master's degree research: "The Effect of the Stimulus Value of a Projective Drawing on the Images Created: Dot to Dot Versus Scribble Projective Drawings." Specializes in clinical art therapy for adolescents and adults.

Marcia Sue Cohen-Liebman, M.A. *(Rutgers University)*, M.C.A.T. *(Hahnemann University)*, A.T.R.-B.C., *Adjunct Assistant Professor.* Forensic art therapy specialist. Consultant to private practice, specializing in the evaluation of domestic litigation cases using comprehensive procedures for art therapy assessment. Developed and teaches the Forensic Art Therapy elective course. Consults nationally with law enforcement professionals, lawyers, and psychologists.

Michael Fogel, M.A., A.T.R.-B.C.. *(MCP Hahnemann University)*; master's degree research: "On the Use of Patients' Humorous Art Productions in Art Psychotherapy." Clinical experience with the elderly chronically ill and with children and adolescents. Co-coordinator of the Family Court Visitation Initiative in Philadelphia. Currently in private practice. Teaches first-year Group Art Therapy Supervision, individual clinical art therapy supervision, and thesis advisement.

Nancy Gerber, M.S., A.T.R.-B.C. *(Hahnemann Medical College and Hospital), Director of Graduate Art Therapy Education and Associate Professor.* More than 20 years of psychiatric clinical art therapy experience with adults and adolescents. Interests and expertise are in the areas of art therapy assessment and treatment, education, and supervision. Developed the Brief Art Therapy Screening Evaluation (BATSE). Has published on the subject of developmental art therapy assessment and treatment implications. Chair of the Accreditation Task Force and member of the Subcommittee on Continuing Education for the American Art Therapy Association. Enrolled in a doctoral program, with the goal of developing a doctoral education program in art therapy education.

Kerith L. Glass-Kraft, M.A. *(MCP Hahnemann University)*, Ed.S., C.C.P., A.T.R.-B. C.. Has presented extensively on pediatric medical art therapy and has presented at the National Kidney Foundation, the Delaware Valley Transplant Program, and America's Health Network. Developed and teaches the Adult Medical Art Therapy course. Currently completing doctoral work in school counseling and integrating this with her work in the schools as an art therapist. Designed elective and continuing education course "Education Based Art Therapy."

Ronald Hays, M.S., A.T.R.-B.C. *(Hahnemann Medical College and Hospital), Director of Creative Arts in Therapy Program, Associate Professor.* Has developed two art treatment projectives: the Dot to Dot and the Bridge drawing. Has interests in art therapy projectives and assessments, arts medicine, art therapy and business, and supervision in the creative arts.

Susan Kaye-Huntington, Psy.D., A.T.R.-B.C. *(Hahnemann Medical College and Hospital), Adjunct Assistant Professor.* Specializes in art psychotherapy, psychotherapy, pain management, and hypnosis with children. Has clinical expertise and interest in the treatment of childhood depression. Studied psychoanalytic theory with Anna Freud at the Anna Freud Center in England.

Laura Black Keenan, M.C.A.T., A.T.R.-B.C. *(Hahnemann University), Adjunct Clinical Instructor.* Designed and taught the first course on medical art therapy in the nation, which has been offered at MCP Hahnemann University and now at Drexel.

Has consulted with the Delaware Valley Transplant Society and the National Multiple Sclerosis Society on implementing art therapy services for family members of those with serious illnesses.

Tina Montagna-Tate, M.A., A.T.R.-B.C. *(MCP Hahnemann University)*; master's degree research: "Drawing Stories: Using Storytelling and Art Therapy with Children." Clinical experiences with adults in acute psychiatric treatment. Certification in school counseling in progress. Teaches Special Art Therapy Literature, guest lectures, individual clinical art therapy supervision, and thesis advisement.

Kathe Cahn Morse, Psy.D. *(Widener University)*, M.C.A.T. *(Hahnemann University),* Adjunct Assistant Professor. Has extensive clinical experience working with children, adults, and families. Advisor on master's degree thesis committees and doctoral dissertation committees.

Michelle Rattigan, M.A., A.T.R., NCC, LPC *(Medical College of Pennsylvania and Hahnemann University)*; master's degree research: "Art Therapy with Women Experiencing the Change of Life." Specializes in conducting group art therapy and group psychotherapy. Teaches the Group Art Therapy course.

Dance/Movement Therapy Program

Established in 1974, the 60-semester-hour Dance/Movement Therapy program is approved by the American Dance Therapy Association. Didactic, clinical, and supervisory aspects are balanced to provide a foundation of theoretical knowledge and practical application. The curriculum integrates knowledge of dance/movement therapy with current theory and approaches to assessment and treatment. Faculty members are selected for their knowledge of and interest in the field and for their ability to assist students in integrating creative arts therapies with general mental health practices.

Through observation and intervention techniques, coupled with an understanding of pertinent literature in dance/movement therapy, students acquire expertise in eliciting client responses and addressing those responses with a creative, systematic, and purposeful approach.

Curriculum

The curriculum is presented according to a full-time schedule. A three- or four-year schedule is designed individually for students who need part-time study. Part-time students are expected to commit the equivalent of at least a two days per week to their studies in the program.

First Year

Requirements		Credits
ANAT 533	**Anatomy and Kinesiology**	2
ANAT 534	**Neuroanatomy/Neurophysiology**	2
ARTS 508	**Developmental Body Movement**	2
ARTS 518	**Introduction to Dance/Movement Therapy I**	1.5
ARTS 519	**Introduction to Dance/Movement Therapy II**	1.5
ARTS 554	**Dance/Movement Therapy Literature Seminar**	1
ARTS 600	**Dance/Movement Therapy Thesis Research I**	1
ARTS 764	**Movement Observation I**	1
ARTS 765	**Movement Observation II**	1
ARTS 766	**Dance/Movement Therapy Clinical Practicum I**	2
ARTS 768	**Dance/Movement Therapy Clinical Practicum II**	2
ARTS 773	**Dance/Movement Therapy Skills—Children I**	1.5
ARTS 774	**Dance/Movement Therapy Skills—Children II**	1.5

ARTS 833	**Dance/Movement Therapy Group Supervision I**	1
ARTS 834	**Dance/Movement Therapy Group Supervision II**	1

Second Year

Requirements		Credits
ARTS 593	**Family Movement Therapy**	1
ARTS 601	**Dance/Movement Therapy Thesis Research II**	2
ARTS 602	**Dance/Movement Therapy Thesis Research III**	2
ARTS 775	**Advanced Movement Observation**	1
ARTS 785	**Advanced Skills—Dance/Movement Therapy I**	1
ARTS 786	**Advanced Skills—Dance/Movement Therapy II**	1
ARTS 790	**Dance/Movement Therapy Clinical Internship I**	1
ARTS 791	**Dance/Movement Therapy Clinical Internship II**	1
ARTS 841	**Advanced Dance/Movement Therapy Group Supervision I**	1
ARTS 842	**Advanced Dance/Movement Therapy Group Supervision II**	1

Note: Please refer to Creative Arts in Therapy for core course requirements.

Dance/Movement Therapy Faculty

Debra Abrams, M.C.A.T., ADTR, CBT, *Adjunct Senior Instructor.* Specialties in child therapy and bioenergetic therapy.

Jacqueline Blatt, M.C.A.T., ADTR, *Clinical Assistant Professor*

Martha Davis, Ph.D., *Clinical Associate Professor and Research Consultant.* Research in nonverbal communication and movement psychodiagnosis.

Dianne Dulicai, Ph.D., M.A., ADTR, NCC, *Adjunct Associate Professor and Senior Consultant.* Research in family development and developmental neuroanatomy.

Gayle Gates, M.A., ADTR *(Immaculate Heart College)*, NCC, *Associate Director of Dance/Movement Therapy Education.* Research interests include child populations and parent/child studies.

Sharon W. Goodill, M.C.A.T., ADTR *(Hahnemann University),* NCC, *Director of Dance/Movement Therapy Education and Associate Professor.* Research interests include medical dance/movement therapy, mind/body interactions, and trauma.

Ellen Schelly Hill, M.M.T., ADTR, NCC, *Adjunct Assistant Professor.* Specialties in mental health systems and clinical training.

Cynthia Howard-Jones, M.C.A.T., ADTR, NCC, *Adjunct Assistant Professor.* Specialties in community arts and CAT supervision.

Tabitha Leatherbee, M.C.A.T., ADTR, NCC, *Clinical Senior Instructor.* Specialties in geropsychiatry and publishing.

Catherine McCoubrey, M.C.A.T., ADTR, C.M.A., NCC, *Clinical Senior Instructor.* Specialty in Laban Movement Analysis (LMA).

Trish Miron, M.C.A.T., ADTR, NCC, *Adjunct Senior Instructor.* Specialties in autism and child development.

Adina G. Rosenberg, M.C.A.T., ADTR, LPC, *Clinical Instructor.* Specialties in programming for children and professional credentialing.

Dorothy D. Rosenbluth, M.A., ADTR, *Adjunct Senior Instructor.* Specialties in LMA and eating disorders.

Elise B. Tropea, M.C.A.T., ADTR, *Adjunct Senior Instructor.* Specialties in child development, prevention models, and eating disorders.

Music Therapy Program

The two-year Music Therapy program is designed to help students develop advanced music therapy clinical skills in an academic health center setting. It was the first to be approved by both the National Association for Music Therapy and the American Association for Music Therapy (the two merged as the American Music Therapy Association in 1998).

The program is the only music therapy training model housed in an academic health center. It is unique in that core-course faculty members are mental health and medical professionals who can assist students in integrating music therapy with current mental health and medical practices. Music therapy modality faculty members represent a wide range of clinical expertise.

Didactic and clinical aspects are balanced to provide a foundation of theoretical knowledge and practical application. The curriculum integrates knowledge of music therapy with current theoretical approaches to assessment and treatment.

Curriculum
The curriculum includes core and music therapy courses. The core curriculum focuses on human development, psychopathology, neuroanatomy, group dynamics, models of therapy, creative arts therapy theory, research, and clinical articulation skills. Literature resources from psychodynamic, humanistic, and medical perspectives are integrated with theories of development, creativity, and the response to the arts experience. In this way, music therapists develop a shared vocabulary with other health care practitioners while maintaining their unique clinical identity.

Music therapy courses use experiential and didactic methods to develop skills and flexibility in clinical approaches with children and adults. Clinical fieldwork, internships, and supervision allow students to merge personal experience with theory.

Electives include Jungian psychotherapy, arts medicine, advanced clinical improvisation, and Ericksonian hypnosis, all designed for the creative arts therapist.

Students have two major supervised opportunities to conduct research: (1) psychology of music—research into the influence of music on behavior; (2) student thesis—applications of quantitative and qualitative approaches to research related to the students' clinical experiences or other areas of interest involving clinical phenomena, development of assessments and theory, or research related to the profession of music therapy. Students may elect to publish their research in music therapy and other health care journals with help from the faculty. Students present their course-related and thesis research in departmental and University-wide forums and at regional and national music therapy conferences.

Under the supervision of a music therapist, students complete more than 1,200 hours of clinical graduate practicum and internship. Placements include psychiatric and general hospitals, partial hospital programs, therapeutic day care, preschool intervention programs, rehabilitation settings, geriatric settings, forensic settings,

schools, community music therapy settings, and home visits.

First Year

Requirements		Credits
ANAT 533	**Anatomy and Kinesiology**	2
ARTS 510	**Clinical Guitar Methods**	1
ARTS 511	**Clinical Piano Methods**	1
ARTS 522	**Clinical Musical Improvisation I**	2
ARTS 523	**Clinical Musical Improvisation II**	2
ARTS 525	**Theories in Music Therapy I**	1
ARTS 526	**Theories in Music Therapy II**	1
ARTS 529	**Music Therapy Skills I**	2
ARTS 530	**Music Therapy Skills II**	2
ARTS 548	**Psychology of Music Therapy I**	2
ARTS 549	**Psychology of Music Therapy II**	2
ARTS 600	**Music Therapy Thesis Research I**	1
ARTS 766	**Clinical Practicum I**	2
ARTS 768	**Clinical Practicum II**	4
ARTS 833	**Music Therapy Group Supervision I**	1
ARTS 834	**Music Therapy Group Supervision II**	1

Elective

ANAT 534	**Neuroanatomy/Neurophysiology**	2

Second Year

Requirements		Credits
ARTS 601	**Music Therapy Thesis Research II**	2
ARTS 602	**Music Therapy Thesis Research III**	2
ARTS 739	**Literature Seminar—Music Therapy**	1
ARTS 787	**Advanced Skills—Music Therapy I**	1
ARTS 788	**Advanced Skills—Music Therapy II**	1
ARTS 790	**Clinical Internship I**	3-6
ARTS 791	**Clinical Internship II**	3-6
ARTS 841	**Advanced Music Therapy Group Supervision I**	1
ARTS 842	**Advanced Music Therapy Group Supervision II**	1

Music Therapy Faculty

John Berns, Ph.D., MT-BC *(Temple University), Adjunct Instructor.* Music therapist in a wide range of clinical populations.Research interests: child cognitive development; music development as it relates to music therapy.

Pamala Dalbo, M.M., MT-BC *(Immaculata College), Instructor.* Developed several pediatric music therapy programs in the Philadelphia area. Research interests: music and child development; music therapy in motor development in handicapped children.

Katherine Hartley-Opher, M.C.A.T., MT-BC *(Hahnemann University), Adjunct Senior Instructor. Executive Director, American Association for Music Therapy, 1991-94.* Research interests: pediatric oncology, the effects of music and imagery on pain

reduction in pediatric oncology patients; integrating music therapy within an autistic support classroom; community music therapy in a family court setting.

Florence Ierardi, M.M., MT-BC *(Temple University), Instructor, Director of Community Connections at the Kardon Institute of the Arts.* Concerto soloist with several orchestras, chamber artist, guest instructor for Drumming for Wellness Retreat. Research interests: effects of percussion playing on the nervous system; rhythm-based assessment models.

Ted Jordan, M.C.A.T., MT-BC *(Hahnemann University), Instructor of Mental Health Sciences.* Developed guitar program for elementary school teachers on the Caribbean island of St. Vincent's. Research interest: effects of music and dance movement responses by Alzheimer's patients.

Joanne Loewy, DA, MT-BC *(New York University), Adjunct Instructor.* Developed pediatric music therapy programs at Beth Israel Medical Center in New York and at Children's Hospital in Philadelphia. Has edited two books: Music Therapy and Pediatric Pain and Music Therapy in the Neonatal Intensive Care Unit. Research interest: music therapy in asthma, sedation, and pain.

Linda Marston, M.C.A.T., MT-BC *(Hahnemann University),Adjunct Instructor.* Many presentations of music therapy clinical work at regional and national music therapy conferences. Research interests: music therapy in psychosocial rehabilitation; song writing with brain-injured adults; the role of music in reducing aggressive outbursts; developing vocalization ability in ventilator-dependent children.

Paul Nolan, M.C.A.T., MT-BC *(Hahnemann Medical College and Hospital), Director of Music Therapy Education, Associate Professor.* Author of several book chapters and articles. Research interests: music and child development; outcome studies in music therapy; analysis of musical behaviors in music therapy; psychological responses to music therapy.

Drexel University
Catalog 2002 2003

Emergency and Public Safety Services

The Master of Science in Emergency and Public Safety Services (formerly Master's in Emergency Medical Services) program comprises two elements: core coursework and then declaration of a specialty area for concentrated coursework and a thesis. The three identified concentrations are Education, Emergency Management, and Ambulatory/ED Management. Each concentration requires a thesis, bringing the total number of credits to the range of 41 to 45, depending on the track and the length of thesis work.

Courses are available through the traditional classroom interaction at Drexel's College of Nursing and Health Professions or through distance education.

The goals and objectives of the program are to:

- *Demonstrate a broader knowledge base and new applications of clinically relevant information that will extend the student's professional competence*
- *Facilitate the knowledge and skills necessary to conduct independent research*
- *Promote leadership and management in the public-services arena*
- *Provide options for an employment progression for prehospital providers in their field of interest*
- *Continue the growth of professionalism in public safety services by providing opportunities for students to take an active role in shaping policies and practices that affect the direction of the profession*
- *Positively affect the communities in which they serve and extend the University's reach into the community*
- *Develop a flexible curriculum that allows for specialization into one of three primary educational areas pertinent to emergency management*

Curriculum
The Master of Science in Emergency and Public Safety Services is designed to expand the skills and knowledge of individuals interested in the broad arena of public safety services. This includes those involved in prehospital services from clinical care and disaster management to those in ambulatory services. Fire, police, rescue, telecommunication, and EMS personnel are all included in the scope of public safety services. There are many overlapping issues between the services, which allows for a coherent expansion of curricula to meet the educational needs of all participants.

Curriculum Objectives

- *To provide relevant knowledge and skills in the variety of subject areas necessary to develop the high-level management skills of emergency management personnel*
- *To provide students with research and writing opportunities to facilitate independent research and publication*
- *To develop professionals who are able to use and adapt principles of leadership to direct the dynamic and changing world of public-safety services*
- *To develop an orientation toward lifelong learning*

Core Curriculum

The core consists of seven foundation courses, which students in all tracks take.

Requirements		Credits
EDUC 510	**Research**	3
EMS 504	**Organizational Behavior**	3
EMS 505	**Proseminar**	3
EMS 508	**Finance**	3
EMS 510	**Planning and Administrative Theory**	3
EMS 610	**Epidemiology**	3
MGMT 510	**Health Care Information Systems and Informatics**	3

Concentrations

Education

Requirements		Credits
EDUC 520	**Principles of Education: The Adult Learner**	3
EDUC 521	**Principles of Education: Adult Learner Laboratory**	1
EDUC 522	**Principles of Education: Instructional Design**	3
EDUC 523	**Instructional Design Laboratory**	1
EDUC	**Computer Multimedia Authoring***	3
EMS 710/711	**Thesis**	6-9
	Elective	3

Emergency Management

Requirements		Credits
EMS 509	**Trauma Systems and Specialty Care**	3
EMS 617	**Emergency Delivery Systems**	3
EMS 618	**Local, State, and Federal Compliance**	3
EMS 622	**Managed Care Principles**	3
EMS 631	**Disaster Analysis and Management**	3
EMS 710/711	**Thesis**	6-9

Ambulatory/ED Management

Requirements		Credits
EMS 506	**Clinical Management I**	3
EMS 507	**Clinical Management II**	3
EMS 509	**Trauma Systems and Specialty Care**	3
EMS 622	**Managed Care Principles**	3
EMS 710/711	**Thesis**	6-9
EMS	**Ambulatory Health Care Delivery Systems***	3

***Contact department for course number.**

Admission Requirements

To gain the full benefit of this educational experience, applicants must have knowledge and experience in EMS, fire, public safety, law enforcement, or telecommunications or in a related field.

Applicants must have a grade point average of 3.0 or better, must have had satisfactory scores on the GRE or MAT examinations, and must have completed an introductory statistics course. Official copies of undergraduate transcripts and three letters of recommendation must accompany completed applications.

A personal interview is required. The program uses a rolling admissions policy; students are admitted for programs beginning in the fall, spring, and summer.

Faculty

Program faculty are established figures in EMS--at the national, state, and local levels--who are committed to developing the individual talents of each graduate student. Students are encouraged to maximize their learning through publishing, research, and practicum opportunities.

Faculty members include:

Richard Fuller, M.Ed., EMT-P

John Lewis, Ed.D.

Jean B. Will, Ed.D, R.N., M.S.N, EMT-P

Drexel University
Catalog 2002 2003

Law/Psychology

Drexel University and Villanova University Law School offer a joint and integrated program in law and psychology leading to the Juris Doctor (J.D.) in law from Villanova and the Doctor of Philosophy (Ph.D.) in clinical psychology from Drexel. The psychology component is housed in Drexel's Department of Clinical and Health Psychology and is fully accredited by the American Psychological Association.

Curriculum
Law and psychology are related in many significant ways, yet few people are trained and skilled to strengthen this relationship. Many institutions permit students to pursue both degrees in an informal, uncoordinated manner. By contrast, Drexel University and Villanova train students in a carefully developed, integrated, conceptually unified program so that they acquire a mature understanding of the interaction between the two disciplines.

Over the seven-year course of study, students maintain continuous contact with the faculties of both schools and the developments in both disciplines.

As the following sample curriculum reveals, students are enrolled concurrently in both universities and are required to fulfill the requirements of the J.D. and Ph.D. degrees. Students take courses in both institutions for the first six years; the emphasis in the first year is in law and the emphasis in the second year is in psychology. Time is about evenly divided between the institutions in the third through the sixth years.

At the end of the sixth year, students are awarded the J.D. degree from Villanova. During the seventh year, students undertake a full-time supervised psychology internship in an approved setting and complete their dissertation. Students then receive the Ph.D. degree from Drexel.

At the conclusion of the program, students are eligible for admission to the bar and, after completing the postdoctoral requirement for supervised experience in a given state, licensure as a psychologist.

The curriculum consists of five elements:

- *The required core program in law and psychology at both institutions*
- *Interdisciplinary courses such as Introduction to Law and Psychology, Social Science Applications to Law, Law and Mental Health, Research in Law and Psychology, and Forensic Assessment*
- *Legal clinics and psychology practica and internships that combine knowledge from both fields in a practical setting*
- *Electives in both fields, such as Health Law, Medical Malpractice, Privacy, Behavior Therapy, and Clinical Decision Making*
- *Employment for at least one summer in a legal setting, such as a public-interest law firm, governmental agency, or private law firm*

First Year

Course		Credits
LAW 0110	**Civil Procedure**	3
LAW 0120	**Contracts**	3
LAW 0150	**Criminal Law and Procedure**	2
LAW 0151	**Introduction to Legal Research**	1
LAW 0152	**Introduction to Legal Writing**	1
LAW 0154	**Torts**	3
PSYC 511	**Psychopathology of Adults**	3
PSYC 601	**Theories of Learning**	3
PSYC 730	**Introduction to Law and Psychology**	2

Second Year

Course		Credits
LAW 0153	**Property**	2
LAW 1000	**Constitutional Law I**	3
PSYC 506	**Introduction to Psychotherapy Skills**	1
PSYC 525	**Intellectual Assessment**	3
PSYC 604	**Behavioral Assessment**	3
PSYC 625	**Advanced Statistics**	3
PSYC 710	**Doctoral Research**	6

Third Year

Course		Credits
	Required Category Case	3
PSYC 501	**Social Cognition in Clinical Psychology**	3
PSYC 502	**Developmental Psychology**	3
PSYC 605	**Health Psychology**	3
PSYC 622	**Research Methods in Clinical Psychology**	3
PSYC 631	**Behavioral Therapy I**	3
PSYC 640	**Personality Assessment**	3
PSYC 700	**Clinical Practicum Seminar**	2
PSYC 715	**Law and Mental Health**	3

PSYC 720	**Forensic Assessment**	3
PSYC 725	**Seminar in Advanced Problems in Mental Health Law**	3

Fourth Year

Course		Credits
LAW 7024	**Evidence**	3
LAW 7025	**Family Law***	3
LAW 7028	**Health Law***	2
PSYC 650	**Psychopharmacology**	3
PSYC 655	**Ethics and Professional Issues**	3
PSYC 700	**Clinical Practicum Seminar (Two-Day)**	2
PSYC 705	**Social Science Applications to the Law**	3
PSYC 710	**Doctoral Research**	12

Fifth Year

Course		Credits
LAW 6028	**Legal Profession**	2
LAW 7002	**Administrative Law***	3
LAW 7004	**Advanced Criminal Procedure***	3
LAW 7008	**Children and the Law***	2
PSYC 611	**Intro to Clinical Neuropsychology**	3
PSYC 710	**Doctoral Research in Law and Psychology**	12

Sixth Year

Course		Credits
LAW 7005	**Advanced Legal Writing**	3
LAW 7015	**Dispute Resolution***	2
LAW 7026	**Federal Courts/Federal Systems***	3
LAW 7050	**Trial Practice or Legal Clinic**	1
LAW 7057	**Negotiation and Advanced Mediation***	3
PSYC 710	**Doctoral Research in Law and Psychology**	8
	Electives to complete J.D. requirements**	0
	Electives to complete coursework for Ph.D.**	0
	Completion of dissertation proposal**	0

***These courses are recommended, not required.**

****Contact the department for specific information.**

Faculty

In addition to the faculty listed below, students work with the 13 members of the psychology faculty at Drexel University and the 30 members of the law school faculty at Villanova, many of whom have special interest in social science and mental health issues.

Donald N. Bersoff, Ph.D. *(New York University)*, J.D. *(Yale University), Professor Emeritus.* After a decade as general counsel of the American Psychological Association, Donald N. Bersoff, Ph.D., J.D., became director of the joint-degree program in January 1990 and retired as director in June 2001. He received his Ph.D. from New York University in 1965 and was awarded the ABPP in 1974. He is a Fellow of the APA and the American Psychological Society. He received his J.D. from Yale Law School in 1976 and was a member of the Yale Law Journal. He then founded and coordinated the Law and Psychology Program at the University of Maryland School of Law and the Johns Hopkins University Department of Psychology. In 1979 he became the first general counsel to the APA. In 1981 he helped establish the law firm of Ennis, Friedman, Bersoff & Ewing, which in 1988 merged with Jenner & Block, where he was a partner. He also served a three-year term (1994-97) on the APA Board of Directors.

Naomi Goldstein, Ph.D. *(University of Massachusetts, Amherst), Co-director.* Dr. Naomi Goldstein specializes in forensic psychology and child and adolescent behavior problems. Dr. Goldstein's general research interest is in juvenile offenders, and she focuses on the mental health treatment needs of girls in the justice system. Her research involves the development of intervention programs for adolescent female offenders; while preventing future crime, this research is also designed to explain causal relationships between mental health problems and delinquency in this underserved adolescent group. Dr. Goldstein is also currently conducting research on adolescents' comprehension of Miranda rights and false confessions. Dr. Goldstein has a Ph.D. in clinical psychology from the University of Massachusetts, Amherst. She completed a clinical internship at the University of Massachusetts Medical Center in Worcester. She teaches graduate statistics and child psychopathology and treatment at Drexel.

Kirk Heilbrun, Ph.D. *(University of Texas at Austin), Professor and Department Chair.* In 1995, Kirk Heilbrun, Ph.D., joined the program faculty. Dr. Heilbrun, who specializes in forensic psychology, received his doctorate in clinical psychology from the University of Texas at Austin in 1980, and completed a postdoctoral fellowship in the Applications of Psychology to Crime, Delinquency, and Criminal Justice at Florida State University in 1981-82. He is a Diplomate in Clinical Psychology and Forensic Psychology, ABPP, and a Fellow of APA. He previously served as Chief Psychologist at the Forensic Service, Florida State Hospital, and on the faculty of the Medical College of Virginia. He has research and practice interests in forensic assessment, violence risk assessment, and juvenile delinquency. Dr. Heilbrun also serves as the Chair of the Department of Clinical and Health Psychology.

Richard Redding, Ph.D. *(University of Virginia),* J.D *(Washington and Lee University), Director.* Dr. Redding is an Associate Professor at Drexel and at Villanova University School of Law, and provides coordination, monitoring, and advice to all students in the program. He teaches in the areas of social science and the law, criminal law, and mental health law. His research focuses on sentencing policy for juvenile offenders, the mental health needs of juvenile offenders, the use of social science in law, and biases of social science research and its use in law and policy making. He

has received awards for his work from the American Psychology Law Society and the Society for the Psychological Study of Social Issues. Dr. Redding was formerly Assistant Professor and Associate Director of the Institute of Law, Psychiatry, and Public Policy at the University of Virginia School of Law. After law school, he clerked for the Honorable Michael Farrell at the D.C. Court of Appeals. In addition to practicing law, he has worked in various policy-making and consulting positions and as a clinician with children and families. Dr. Redding received his M.S. in psychology from Vanderbilt University, his Ph.D. in psychology from the University of Virginia, and his J.D. degree from Washington and Lee University, where he was the Frances Lewis Law Fellow.

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Nursing Programs (M.S.N.)

The Master of Science in Nursing programs prepare leaders in advanced practice roles. Nurses in advanced practice are professionals committed to delivering and improving high-quality service while shaping the health care system of the future. Courses from nursing and other disciplines provide advanced theoretical knowledge, assessment skills, role and leadership development, advanced practice in a selected specialization, and the opportunity to critique and apply nursing theory and research as a scientific base for nursing practice.

Congruent with the changing needs of society, the master's programs offer a number of specialty options to students. Concentrations are available as follows:

- Clinical Trials Research
- Education
- Leadership and Management
- Nurse Anesthesia
- Nurse Practitioner
    - Acute Care Nurse Practitioner
        - Perioperative Concentration
    - Family Nurse Practitioner
        - Emergency/Fast Track Concentration
    - Pediatric Nurse Practitioner
    - Psychiatric–Mental Health Nurse Practitioner
    - Women's Care Nurse Practitioner (an M.S.N.completion program offered in collaboration with the Planned Parenthood Federation of America)
- Public Health Nursing

Courses are offered in day and evening sessions and may also be Web-based.

Accreditation
All graduate nursing programs are accredited by the Pennsylvania State Board of Nursing; the National League for Nursing Accreditation Commission, 61 Broadway, New York, NY 10006; 212-363-5555; and the American Association of Colleges of Nursing, One Dupont Circle, NW, Suite 530, Washington, DC 20036.

The Nurse Anesthesia Master of Science in Nursing program is accredited by the Council on Accreditation of Nurse Anesthesia Educational Programs, 222 South Prospect Avenue, Suite 304, Park Ridge, IL 60068, 847-692-7050.

Graduate Curriculum
Graduate education at the Drexel University College of Nursing and Health Professions builds on the education and practice experiences of the adult learner and is characterized by a focus on specialization and a commitment to and involvement in the development and refinement of nursing knowledge. Advanced nursing practice involves theoretically based diagnostic reasoning and decision-making strategies in solving complex client problems. The curriculum is based on the following assumptions:

- *All areas of specialization have in common a core of advanced nursing knowledge.*
- *Every graduate must have knowledge and skill in research and the ability to evaluate and apply research findings.*
- *The nursing profession anticipates and responds to changing societal, health care, and professional needs.*
- *The foundation for specialization in professional nursing practice is graduate-level education that builds on undergraduate education.*

M.S.N. for Nurses with a Non-Nursing B.A./B.S.

An R.N./M.S.N. "bridge" program is available for nurses who hold a non-nursing B. A. or B.S. Applicants to this program must complete the admission process to the M.S.N. program and seek initial advisement from the academic advisor and from the appropriate graduate program director. The graduate program director reviews the applicant's file for program eligibility, and prerequisites are established on an individual basis.

In general, applicants must take or test out of two designated B.S.N.-level courses —NURS 334: Nursing in Environments of Change, and NURS 402: Public Health Nursing. After successfully completing all requirements, and after admission to the M.S.N. program, students progress directly into graduate-level courses.

Note: The B.S.N. is not awarded in this program.

Certification Programs

Certificate programs are currently available in the concentrations of Clinical Trials Research, Education, and Leadership and Management. These programs are for individuals who seek further knowledge in the specialty area of choice. They are designed to be completed totally online.

Post-Master's Certification Programs

Post-master's certificate programs are designed for individuals who have earned a master of science degree in nursing and seek further preparation to qualify for state or national certification as a nurse practitioner or nurse anesthetist. Nurse practitioner students can complete the program in one year of part-time study. The Nurse Anesthesia Post-Master's Certificate program requires 27 months of full-time study for completion.

M.S.N. Completion Programs

An option that enables graduates of certificate nurse anesthesia and nurse practitioner programs to earn the Master of Science in Nursing degree is available. Applicants to these M.S.N. completion programs will have their program of study designed on an individual basis.

Core courses provide a basis for the analysis of advanced practice that is based in theory, research, and knowledge of political, ethical, and social processes to ensure high-quality health care for consumers.

Support courses are specific to the student's area of concentration. They enhance the core courses and provide additional foundation for the practicum content.

Practicum courses focus on the application and integration of theory to advanced practice situations. Practicum courses are specific to the concentration.

Electives give students the opportunity to select additional course offerings from the nursing program or from any other graduate program in the University. Nurse anesthesia students do not take elective courses.

Up to 15 credits may be transferred from another accredited graduate school toward a master's degree with the approval of the program director. Any credits transferred toward a degree must be equivalent to the required courses offered for credit at Drexel University for that degree.

Curriculum Overview

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College of Nursing and Health Professions Faculty

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Clinical Trials Research

This program prepares nurses for involvement in clinical trials and clinical research in a variety of roles and settings. The core and support courses form the foundation for the clinical trials curriculum. The program of study includes content on federal drug regulation, investigative aspects of new drugs and devices, informed consent, institutional review, roles, responsibilities, budgeting, and legal and ethical issues related to clinical research and trials. Students will participate in a 120-hour clinical practicum with a clinical trials researcher in an area of the student's interest. After completing the program, graduates will be prepared to conduct clinical trials and work as clinical research coordinators and scientists in a variety of settings, including hospitals, drug companies, and private industry.

M.S.N. - Clinical Trials Research (39 credits)

Core courses		Credits
NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Support courses

NURS 520	**Physiology for Advanced Nursing Practice**	3
NURS 600	**Advanced Clinical Assessment**	6
NURS 605	**Pharmacology for Advanced Nursing Practice**	3

Elective courses

	Electives	3

Practicum courses

NURS 581	**Clinical Trials Research I**	3
NURS 685	**Clinical Trials Research II**	3
NURS 686	**Clinical Trials Research Practicum**	6

Certificate - Clinical Trials Research (9 Credits)

Courses		Credits
NURS 581	**Clinical Trials Research I**	3
NURS 685	**Clinical Trials Research II**	3
NURS 686	**Clinical Trials Research Practicum**	3

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Education

The nurse educator may be found in a myriad of settings, including hospitals, long-term care facilities, community centers, and corporate and philanthropic organizations. This program prepares nurses to become educational leaders. Program content includes integration of theories specific to adult learning, curriculum design, and evaluation of courses and programs. The program combines theory, research, and practice from the disciplines of education, management, and leadership. This content is applicable in a variety of settings in both the academic and clinical arenas.

M.S.N. - Education (39 credits)

Core courses		Credits
NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Support courses		
NURS 507	**Leadership and Stewardship**	3
NURS 520	**Physiology for Advanced Nursing Practice**	3
NURS 544	**Learning as Transformation: Concepts and Strategies**	3
NURS 545	**Evaluating Learning and Teaching**	3
NURS 546	**Program Design and Instructional Technologies**	3
NURS 600	**Advanced Clinical Assessment**	6

Practicum courses		
NURS 654	**Education Symposium and Practicum**	6

Certificate - Education (9 credits)

Courses		Credits
NURS 544	**Learning as Transformation: Concepts and Strategies**	3
NURS 545	**Evaluating Learning and Teaching**	3
NURS 546	**Program Design and Instructional Technologies**	3

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Leadership and Management

This program prepares the student to be a nursing leader in today's rapidly changing health care environment. The program focuses on development of a leadership style and skills set, fiscal management, legal and ethical issues affecting individuals and organizations, strategic planning, integrated quality outcomes measurement, organizational structures, and marketing and management of human resources within organizations. The program provides the student with information and strategies to solve problems, make decisions, resolve conflict, and operationalize the mission and goals of the health care delivery system.

M.S.N. - Leadership and Management (36 credits)

Core courses		Credits
NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Support courses		
NURS 507	**Leadership and Stewardship**	3
NURS 541	**The Business of Health Care**	3
NURS 542	**Human Resources and Employee Relations**	3
NURS 543	**Legal Issues in Health Care**	3
NURS 652	**Information Systems in Health Care**	3

Elective course		
	Electives	3

Practicum course		
NURS 653	**Leadership and Management Symposium and Practicum**	6

Certificate - Leadership and Management (9 credits)

Courses		Credits
NURS 507	**Leadership and Stewardship**	3
NURS 541	**The Business of Health Care**	3
NURS 542	**Human Resources and Employee Relations**	3

Nurse Anesthesia

The M.S.N. in Nurse Anesthesia is a 27-month, 66-credit, full-time program that prepares students for entry into nurse anesthesia practice. On completing the program, graduates are eligible to take the national certification examination offered by the Council on Certification of Nurse Anesthetists. The program has a 6-credit theoretical nursing component, a 6-credit research component, a 12-credit basic science component, a 24-credit anesthesia component, and an 18-credit clinical component.

Students receive all didactic and research-related coursework at the University's Center City Hahnemann Campus. They receive all clinical experiences at one of five off-campus primary clinical sites. Five additional sites are available to students for obstetric and pediatric anesthesia rotations and for general nurse anesthesia practice. Students typically administer approximately 650 anesthetics in a wide variety of surgical and diagnostic procedures for a total of 1,500 hours.

The Nurse Anesthesia program begins annually in January. Applications are reviewed continually. Applications should be made 12 to 18 months in advance of the anticipated January start date. Interviews are conducted throughout the year. Candidates who are accepted into the program may be able to take some of the core and support courses on a non-matriculated basis before their formal start of the program.

M.S.N. - Nurse Anesthesia (66 credits)

Core courses		Credits
NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Support Courses		
NURS 520	**Physiology for Advanced Nursing Practice**	3
NURS 521	**Advanced Pathophysiology for Nurse Anesthetists**	3
NURS 560	**Overview of Nurse Anesthesia I**	3
NURS 561	**Basic Principles of Nurse Anesthesia**	3
NURS 562	**Overview of Nurse Anesthesia II**	3
NURS 605	**Pharmacology for Advanced Nursing Practice**	3
NURS 655	**Clinical Practicum Seminar I**	3

NURS 656	**Clinical Practicum Seminar II**	3
NURS 657	**Chemistry and Physics Related to Nurse Anesthesia**	3
NURS 660	**Advanced Principles of Nurse Anesthesia I**	3
NURS 661	**Applied Pathophysiology for Nurse Anesthesia**	3
NURS 663	**Advanced Principles of Nurse Anesthesia II**	3

Practicum courses

NL	**Clinical Practicum Orientation**	0
NURS 565	**Nurse Anesthesia Clinical Practicum I**	3
NURS 566	**Nurse Anesthesia Clinical Practicum II**	3
NURS 665	**Nurse Anesthesia Clinical Practicum III**	3
NURS 666	**Nurse Anesthesia Clinical Practicum IV**	3
NURS 667	**Nurse Anesthesia Clinical Practicum V**	3
NURS 668	**Nurse Anesthesia Clinical Practicum VI**	3

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Nurse Practitioner

The College of Nursing and Health Professions offers four nurse practitioner programs, specializing in acute, family, pediatric, and psychiatric-mental health care. The women's care nurse practitioner program is an M.S.N. completion program (see description).

Acute Care Nurse Practitioner

The Acute Care Nurse Practitioner program is designed to prepare practitioners for professional practice in the management of medical, surgical, and critical-care patient populations. Didactic and seminar courses provide a knowledge base of acute and chronic management of adults experiencing deviations from health across systems. Clinical practica allow students to put the principles they have learned into practice in the general medical-surgical and critical care populations, or to specialize within an area of practice. On completing the program, students pursue a variety of practice roles in acute care settings and in the outpatient care and management of adults. Graduates are eligible for licensure as acute care nurse practitioners by the Commonwealth of Pennsylvania and to sit for the ANCC's Acute Care Nurse Practitioner examination.

Also available within the Acute Care Nurse Practitioner track is a Perioperative concentration. This concentration is open to students who wish to focus their nurse practitioner role in the perioperative setting. Students divide their clinical practica between the acute patient setting and the perioperative arena. Content is directed at integrating knowledge obtained through core and support courses and experience as a perioperative nurse into the assessment, diagnosis, and management of common health and illness conditions of the perioperative patient. Students selecting this concentration will be required to take the R.N. First Assistant course (NURS 606) as their six elective credits. Students are eligible to take the Acute Care Nurse Practitioner Certification exam.

Family Nurse Practitioner

The Family Nurse Practitioner (FNP) track focuses on the application of advanced-practice nursing knowledge—including physical, psychosocial, and environmental assessment skills—to manage common health and illness problems of clients of all ages. It emphasizes health promotion and disease prevention. Family nurse practitioners primarily practice in ambulatory-care settings, such as primary care clinics, physician offices, HMOs, outpatient clinics, schools, nursing centers, emergency departments, long-term care facilities, industry, the armed services, public health departments, correctional institutions, and home health agencies. Graduates are eligible for licensure as family nurse practitioners by the Commonwealth of Pennsylvania and to sit for the ANCC's FNP examination or the American Academy of Nurse Practitioners NP examination.

Also available within the Family Nurse Practitioner track is an Emergency/Fast Track concentration, designed for experienced nurses who wish to practice in the emergency-care arena. Graduates work in a variety of clinical settings, including emergency departments, fast-track areas, urgent-care centers, rural clinics, and busy primary care practices that provide minor medical and surgical procedures

within the practice. Clinical placements include both primary care and emergency department practice sites. Students learn emergency-specific skills, such as suturing, abscess incision and drainage, X-ray interpretation and splinting, management of pediatric emergencies, arthrocentesis, and other procedures before beginning their clinical placements. Students are eligible to sit for the Family Nurse Practitioner certifying exams.

Students who elect to take the Emergency/Fast Track concentration follow the Family Nurse Practitioner curriculum with three revisions: Their six credits of elective courses consist of NURS 515: Management of Common Pediatric Emergencies (3 credits) and NURS 517: Basic Office Procedures for Advanced Practice Nurses (3 credits), and the third clinical course in the FNP curriculum is replaced by Diagnostic Reasoning and Clinical Decision Making for Common Emergencies.

Pediatric Nurse Practitioner

The Pediatric Nurse Practitioner (PNP) program is designed to prepare experienced nurses who seek advanced knowledge and skill in delivering primary and tertiary health care to infants, children, and adolescents. Graduates work in a variety of settings, such as community health centers, day care programs, acute and chronic care facilities, outpatient facilities, private practice offices, schools, homes, and health departments. Graduates are eligible for licensure as PNPs by the Commonwealth of Pennsylvania and are eligible to take the certifying examination offered by the American Nurses Association.

Psychiatric–Mental Health Nurse Practitioner

The aim of this program is to prepare psychiatric–mental health nurse practitioners who provide a wide range of services to adults and their families. The program of study is based on a biopsychosocial model of care. It includes the study and application of diagnostic and treatment modalities, and theories and approaches to practice. Graduates practice in a wide variety of settings. They are eligible for licensure as psychiatric–mental health nurse practitioners by the Commonwealth of Pennsylvania and may sit for the ANCC certification examination for the psychiatric–mental health nurse practitioner.

Women's Care Nurse Practitioner (M.S.N. Completion)

This program prepares nurses to provide primary health care services to women in a variety of practice settings. The program is a collaborative endeavor between Drexel University and the Planned Parenthood Federation of America's OB/GYN Nurse Practitioner program. Applicants must be graduates of a NPWH-accredited program, must be intending to enroll in such a program, or may be enrolled concurrently in both the NPWH-accredited program and the University.

Support and clinical courses are taken through the NPWH-accredited OB-GYN Nurse Practitioner program. Six courses (four core courses and two electives, a total of 18 credits) are required for completion of the M.S.N. and are delivered by the University. Graduates are eligible for licensure as women's health care nurse practitioners by the Commonwealth of Pennsylvania and to take the NCC's certification examination.

M.S.N. - Nurse Practitioner tracks (48 credits)

Core courses	Credits

NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Support courses

NURS 520	**Physiology for Advanced Nursing Practice**	3
NURS 600	**Advanced Clinical Assessment**	6
NURS 605	**Pharmacology for Advanced Nursing Practice**	3

Elective courses

	Electives	6

Practicum courses

	See following tables for specifics	18

Acute Care		**Credits**
NURS 540	**Diagnostic Reasoning and Clinical Decision Making for Acute Care Nurse Practitioners I**	6
NURS 640	**Diagnostic Reasoning and Clinical Decision Making for Acute Care Nurse Practitioners II**	6
NURS 641	**Diagnostic Reasoning and Clinical Decision Making for Acute Care Nurse Practitioners III**	6

Family		**Credits**
NURS 530	**Diagnostic Reasoning and Clinical Decision Making for Family Nurse Practitioners I**	6
NURS 630	**Diagnostic Reasoning and Clinical Decision Making for Family Nurse Practitioners II**	6
NURS 631	**Diagnostic Reasoning and Clinical Decision Making for Family Nurse Practitioners III**	6

Pediatric		**Credits**
NURS 570	**Diagnostic Reasoning and Clinical Decision Making for Pediatric Nurse Practitioners I**	6
NURS 670	**Diagnostic Reasoning and Clinical Decision Making for Pediatric Nurse Practitioners II**	6
NURS 671	**Diagnostic Reasoning and Clinical Decision Making for Pediatric Nurse Practitioners III**	6

Psychiatric-Mental Health		**Credits**
NURS 580	**Diagnostic Reasoning and Clinical Decision Making for Psychiatric–Mental Health Nurse Practitioners I**	6
NURS 680	**Diagnostic Reasoning and Clinical Decision Making for Psychiatric–Mental Health Nurse Practitioners II**	6
NURS 681	**Diagnostic Reasoning and Clinical Decision Making for Psychiatric–Mental Health Nurse Practitioners III**	6

M.S.N. Completion - Women's Care Practitioner (18 credits)

Core Courses	**Credits**

NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3

Elective courses

	Electives	6

Post-Master's Certificate - Nurse Practitioner tracks (30 credits)

Support Courses		**Credits**
NURS 520	**Physiology for Advanced Nursing Practice**	3
NURS 600	**Advanced Clinical Assessment**	6
NURS 605	**Pharmacology**	3

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Public Health Nursing

Public health nursing is the practice of promoting and protecting the health of populations using knowledge from nursing, social, and public health sciences. Public health nursing is population-focused, community-oriented nursing practice. The goal of public health nursing is the prevention of disease and disability for all people through the creation of conditions in which people can be healthy. Public health nurses assess the needs and strengths of populations, design interventions to mobilize resources for action, and promote equal opportunity for health. Strong, effective organizational and political skills must complement nursing and public health expertise.

The graduate program in Public Health Nursing prepares advanced practice nurses to provide population-based care. The program focuses on health promotion and disease prevention from the perspective of the population, and prepares graduates who are well suited not only to participate in but also take a leadership role in planning and evaluating individual and community-oriented care. The program is designed for the working professional who is a part-time student.

M.S.N. - Public Health Nursing (42 credits)

Core courses		**Credits**
NURS 505	**Health Policy**	3
NURS 508	**Improving Systems for Health Promotion**	3
NURS 510	**Research and Theory I**	3
NURS 610	**Research and Theory II**	3
Support courses		
NURS 511	**Epidemiology**	3
NURS 512	**Ethics in Public Health Nursing**	3
NURS 548	**Health Economics**	3
Elective courses		
	Electives	6
Practicum courses		
NURS 616	**PHN Theory I**	3
NURS 617	**PHN Theory II**	3
NURS 618	**PHN Theory III**	3
NURS 619	**PHN Clinical I**	3
NURS 620	**PHN Clinical II**	3

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Physical Therapy

The Programs in Rehabilitation Sciences offers several programs in physical therapy at the professional and post-professional levels:

- *Entry-level program (Doctor of Physical Therapy, D.P.T.)*
- *Post-Professional Master's programs (M.H.S. and M.S. degrees), with concentration in Pediatrics, Movement Science, Orthopedics, or Hand/Upper Quarter Rehabilitation*
- *Ph.D. program, with concentration in Pediatrics, Movement Science, or Orthopedics*
- *Certificate program in Hand/Upper Quarter Rehabilitation*

Professional/Entry-Level Program: Doctor of Physical Therapy (D.P.T.)
The Doctor of Physical Therapy program is designed to prepare competent physical therapy clinicians who understand the needs for care and the delivery of care within the changing health care system. The curriculum values the physical therapist as a health care provider who gives particular attention to the anatomical, physiological, and biopsychosocial aspects of the mind and body following both prevention/ wellness and disablement models. Emphasis is placed on examination, evaluation, and intervention plans in order to determine a diagnosis and prognosis to effect optimal outcomes throughout the continuum of care.

D.P.T. Curriculum

First Year

Fall		**Credits**
NEUR 507	**Neuroscience I**	3
PT 509	**Human Gross Anatomy**	5
PT 512	**Kinesiology**	5
PT 515	**Musculoskeletal Examination and Intervention**	5
PT 518	**Applied Human Physiology**	3

Spring		
NEUR 508	**Neuroscience II**	3
PT 505	**Physical Agents**	4
PT 520	**Pathophysiology**	2
PT 538	**Motor Control and Motor Learning**	2
PT 540	**Functional Mobility**	2
PT 555	**Orthopedic PT I**	4

PT 576	**Cardiopulmonary PT I**	3
PT 690	**Clinical Correlations I**	2

Summer: Part A (8 weeks)

PT 770	**Clinical Education I**	4

Summer: Part B (8 weeks)

PT 556	**Orthopedic PT II**	3
PT 560	**Prosthetics and Orthotics**	2
PT 562	**Neurological Examination and Intervention I**	3
PT 670	**Research I: Introduction to Research and Clinical Measurement**	2

Second Year

Fall: Part A (8 weeks)		**Credits**
PT 563	**Neurological Examination and Intervention II**	4
PT 577	**Cardiopulmonary PT II**	3
PT 671	**Research II: Statistics**	2
PT 691	**Clinical Correlations II**	2

Fall: Part B (8 weeks)

PT 771	**Clinical Education II**	4

Spring

PT 524	**Pharmacology**	2
PT 565	**Pediatric PT**	4
PT 635	**Biomechanics**	3
PT 652	**Musculoskeletal Tissues and Pathology**	3
PT 714	**Professional Issues and Ethics**	3
PT 716	**Organization and Administration**	3

Summer: Part A (8 weeks)

PT 640	**Orthopedic PT III**	3
PT 665	**Applications of Motor Control and Learning**	3
PT 672	**Research III: Research Design**	2
PT 757	**Concepts in Clinical Teaching**	3

Summer: Part B (8 weeks)

PT 692	**Clinical Correlations III**	2

Musculoskeletal Concentration

PT 645	**Anatomy and Clinical Management I: Shoulder and Cervical Spine**	2
or		
PT 647	**Anatomy and Clinical Management III: Pelvis and Lumbar Spine**	2
or		
PT 648	**Anatomy and Clinical Management IV:Hip and Knee**	2

Neuromuscular Concentration

PT 637	**Clinical Topics in Neuromuscular Rehabilitation for Adults**	2

Pediatric Concentration

PT 627	**Clinical Topics in Rehabilitation for Children I**	2

Electives

PT 722	**Aquatic PT**	2
PT 724	**Women's Health Issues in PT**	2
PT 764	**Teaching Practicum**	2
PT 766	**Research Practicum**	2

Third Year

Fall: Part A (8 weeks)		**Credits**
PT 772	**Clinical Education III**	4

Fall: Part B (8 weeks)

PT 680	**Evidence-Based Practice**	2
PT 693	**Clinical Correlations IV**	2
PT 719	**Health Policy**	2

Musculoskeletal Concentration

PT 646	**Anatomy and Clinical Management II: Elbow, Wrist and Hand**	2
or		
PT 649	**Anatomy and Clinical Management V: Ankle and Foot**	2
or		
PT 728	**Analysis of Joint Structure**	2

Neuromuscular Concentration

PT 638	**Clinical Topics in Geriatric Rehabilitation**	2

Pediatric Concentration

PT 628	**Clinical Topics in Rehabilitation for Children II**	2

Electives

PT 732	**Complementary Therapies in Rehabilitation**	2
PT 764	**Teaching Practicum**	2
PT 766	**Research Practicum**	2

Spring

PT 785	**Final Project**	2
PT 786	**Clinical Internship**	8

Note: All concentration courses except PT 628 can be taken as electives.

Ph.D. Program

The Doctor of Philosophy (Ph.D.) degree is designed to prepare physical therapists and other professionals to contribute to the knowledge of rehabilitation science through excellence in scholarship, research, and education. The focus of the curriculum is on the knowledge, skills, and experiences necessary to effectively serve as a university faculty member, a research investigator, and a leader within professional and health care organizations. Degree requirements include successful completion of 60 credits for students with a master's degree or 96 credit hours for students with a baccalaureate degree. Concentrations are offered in Movement Science, Orthopedics, and Pediatrics.

There is a two-year residency requirement, which is defined as a minimum of nine credits for four semesters. The semesters need not be consecutive. Students must pass the comprehensive examination, which is similar to the examination taken by the master's degree students. For the Ph.D. degree, this examination is taken after one year of coursework for full-time students. Additionally, doctoral students must pass a qualifying examination, which consists of the dissertation proposal written in grant format and an oral presentation of the proposal followed by a questioning session. This examination is taken when the student has completed required courses and practica and has developed a research proposal. On successfully completing the qualifying examination, the student attains candidacy status. Completion of the original research dissertation is required for the degree.

Certificate Program in Hand/Upper Quarter Rehabilitation

This program is designed for physical and occupational therapists wishing to enhance their knowledge and skills related to the basic science underlying evaluation and clinical intervention of the hand and upper limb as well as the treatment strategies utilized in rehabilitation. The program consists of successful completion of four graduate-level courses, which are offered in a combination of three weekends and over the Internet. Participants must be licensed physical or occupational therapists and have clinical experience in hand/upper quarter rehabilitation.

Physical Therapy Faculty

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Physician Assistant Studies

The fundamental tenet of the physician assistant (PA) profession is that PAs practice as members of physician-directed teams. The American Academy of Physician Assistants defines the PA as “a health professional licensed to practice medicine with physician supervision." In clinical practice, the PA reflects the practice style of the supervising physician or physicians. This relationship defines the PA’s role in health care. The laws and regulations governing PA practice are specific to each state. However, the scope of PA practice depends in great measure on the level of trust and confidence the supervising physician places in the PA. By design, PAs cannot provide medical care, including the prescribing of medication, without physician supervision.

The College of Nursing and Health Professions offers two programs in physician assistant studies:

- Entry-level Physician Assistant Program
- Advanced Physician Assistant Program

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Entry-Level Physician Assistant Program

The Drexel University physician assistant is dedicated to delivering patient care in a wide variety of practice settings with the supervision of a licensed physician who is responsible and legally liable for the performance of the assistant. Graduate PAs diagnose, treat, and monitor a variety of commonly encountered illnesses and injuries in concert with their supervising physicians.

Patient education and counseling, preventive intervention, complete or directed history taking and physical examinations, diagnostic test evaluation, and presentation of cases in a problem-oriented fashion to the supervising physician are only some of the duties of the physician assistant. He or she also performs technical skills such as electrocardiograms, venipuncture, suturing, casting, and injections.

The goals of this program are to:

- *Educate qualified primary care physician assistants*
- *Promote the physician assistant profession*
- *Improve health care delivery in rural and urban medically underserved areas*

Curriculum
The intensive curriculum consists of 114 semester hours of professionally related coursework taken during a continuous 27-month period (the part-time option requires an additional calendar year) and gives students an understanding of both the health care system within which they will work and the functions appropriate to the role of the physician assistant. The curriculum is divided into 13 months of didactic courses followed by 14 months of supervised clinical practice.

Training begins with three semesters of didactic education, which also integrates patient interaction in several of these earliest courses. The clinical training phase begins with a five-week didactic preclinical orientation, which is followed by five-week clinical rotations in medicine, surgery, obstetrics and gynecology, pediatrics, emergency medicine, and psychiatry.

The final portion of the curriculum consists of two 10-week preceptorships. During the preceptorship phase, each student is assigned to two primary care sites for individualized clinical training with physician preceptors. Training sites during the clinical year are located throughout Pennsylvania and in nearby states. Students are expected to relocate during the clinical phase and are responsible for all associated financial costs, including transportation and living expenses.

The program is intensely challenging, both intellectually and physically, and requires stamina as well as personal and financial sacrifice on the part of the students. The program demands a high degree of integrity, self-sufficiency, motivation, and self-discipline, and highly developed study skills.

The Physician Assistant program is moving toward electronic documentation and communications. Therefore, all students are required to have laptop computers that have Web access capability.

Full-time students take all of the courses listed for each semester. Part-time students take the courses on a different timetable, as indicated.

First Year (Full Time)

Summer Semester	Credits
Advanced Anatomy*	4
Advanced Physiology*	3
Research Design and Methods**	3
Research Outcomes and Assessment**	3

Fall Semester	Credits
Principles of Medical Science*	4
Pharmacology I*	2
Physical Diagnosis**	5
History Taking**	2
Ethics and Health Policy*	3

Spring Semester	Credits
Pharmacology II*	2
Clinical Medicine**	7
Emergency Medicine in Primary Care**	3
Epidemiology and Health Promotion*	2
Biopsychosocial Issues in Patient Care*	3
Clinical Laboratory Practicum*	1

***First-year course for part-time students.**

****Second-year course for part-time students.**

Summer Semester	Credits
Foundations of Clinical Medicine	5
Rotation I	5
Rotation II	5

Second Year (Full Time)

Fall Semester Credits	
Rotation III	5
Rotation IV	5
Rotation V	5
Leadership and Stewardship	3

Spring Semester	Credits
Rotation VI	5
Preceptorship	10
Graduate Project I	3

Summer Semester	Credits
Preceptorship II	10
Graduate Project II	6

Physician Assistant Faculty

Advanced Physician Assistant Studies

Drexel University offers the Advanced Physician Assistant Studies program for physician assistants seeking graduate credentials for career advancement and in-depth study in topics such as public health, health policy, education, pharmacology, medical ethics, practice management, and clinical specialties. The curricular design of the program allows for personalized professional development through an adult learner model. The program awards the Master of Health Science (M.H.S.) degree.

The program offers fundamental graduate education courses as a basis for subsequent development in the student's selected area of study. The goal is to enhance basic physician assistant skills and to mentor students in areas of study beyond those offered in entry-level physician assistant programs. The individually selected area of study allows for personalized, professional development augmented by the expertise of seasoned faculty and the University's vast resources. Specifically, the program seeks to:

- *Broaden the base and depth of analytical thinking by providing a foundation for scholarly inquiry*
- *Mentor physician assistants in personalized professional development to enhance the PA profession, its members, and the communities they serve*

The program may be completed on a full-time or part-time basis, either through real-time, face-to-face learning or through online coursework. All requirements for completing the degree must be met within six years of the date of matriculation.

Curriculum
All students complete a total of 33 credits for graduation. Fifteen credits are in core courses, and 18 are devoted to the individual student's area of study—6 credits in cognate courses and 12 credits in graduate project courses. For the exceptional graduate student with significant professional credentials achieved as a physician assistant, preparation and presentation of the professional portfolio to a University-based multidisciplinary committee may substitute for all or portions of the credits required for the two graduate project courses.

Required Core Courses	Credits
Research Design and Methods	3
Research Outcomes Assessment	3
Epidemiology and Health Promotion	3
Health Policy	3
Leadership and Stewardship	3

Study Concentration Courses	Credits
Cognates	6
Graduate Project I	3-6
Graduate Project II	3-6

Alternate Pathway for Study Concentration Courses	Credits

Cognates	6
Portfolio Preparation	1
Portfolio Review	3-12

Physician Assistant Faculty

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The School of Public Health

The Drexel University School of Public Health believes that professionals can best meet the needs of today and tomorrow with expertise in the integration and application of all disciplines of public health.

The School defines its programs based on the needs of neighboring populations and communities and on the effective integration of the traditional public health disciplines of epidemiology, biostatistics, community health, environmental and occupational health, health policy, and health management. This practical approach to learning gives students a solid grounding in the core public health disciplines.

The School of Public Health uses problem-based learning methods to give students the skills of lifelong learning. Also, the School incorporates practical experiences throughout the curriculum. Thus, students translate what they learn into programs that make a difference in people's lives. By working closely with community groups, agencies, and populations in need, the School prepares professionals who can effectively address the most pressing current and future public health challenges.

The School of Public Health offers a Master of Public Health Program.

Master of Public Health Program

The Drexel University Master of Public Health (M.P.H.) program enables students to develop skills and perspective necessary to provide leadership to the nation's public health system, as well as career participation in epidemiology, health services research, management, health promotion, and outcomes evaluation. The school's innovative and student-centered "problem-based curriculum" emphasizes adult learning methods within an integrated and applied educational paradigm.

Students are taught skills required for the planning, development, delivery, and evaluation of health care programs and policies within a variety of programmatic and organizational settings. By developing problem-solving skills within an integrated community context students learn to address pressing current and future public health challenges. Skills developed through the program include health assessment and outcomes research, disease prevention and health promotion, organization and delivery of health services, and policy development and evaluation.

Although the M.P.H. degree is a generalist degree, students have an opportunity to develop concentrated knowledge and skills in a selected core public health discipline (i.e., epidemiology, biostatistics, social and behavioral sciences, environmental and occupational health, or health management and policy).

Curriculum

The Master of Public Health program is intended for individuals interested in careers as community educators, population health planners, policy analysts, evaluators, researchers, and managers of health service delivery organizations and systems, managed-care programs, and other population-based organizations. The program is interdisciplinary and requires students to complete a comprehensive community-based master's project. It prepares students to enter an array of fields related to public health or a range of doctoral programs.

Master's-level work includes content in four areas:

- *Biostatistics and epidemiology*
- *Community health and prevention*
- *Environmental and occupational health*
- *Health policy and management*

All coursework is offered within the context of culture and community.

In addition to the master's project, students are required during the second year of the program to select a concentration in one of these four areas.

The curriculum is divided into discrete 4- to 12-week blocks, with the primary learning objectives of each block focused on one or two core disciplines of public health. In addition to group case discussion sessions, case-related activities are integral to the student experience. They include the following:

- *Resource sessions (both years) provide students access to the expertise of scholars, institutional directors, and community leaders*
- *Case symposia (both years) provide opportunities to write collaboratively, build collegial teams, and develop communication and public-speaking skills.*
- *Site visits (first year) to community agencies, organizations, and health care providers foster an appreciation of public health in a complex urban setting.*
- *Concentration seminars (second year) provide opportunities for students to pursue learning, application, and integration of knowledge within their selected major discipline.*
- *Service-learning workshops (first year) allow students to combine community service with academic preparation and reflection.*
- *Skill development labs (both years) provide hands-on experience.*

The program requires a minimum of 52 semester hours. Students must complete and defend a community-based project. Students should complete this requirement in two years.

Joint Doctor of Medicine and Master of Public Health Program
Students wishing to complete a course of study earning the joint M.D./M.P.H. degree can complete such a program in three years. They must apply for the joint program and be accepted by both the Drexel University College of Medicine and the School of Public Health. Students in this program have enriched public health content in their first two years of medical school and spend their third year of study full time in the School of Public Health. Students are able to enter clinical rotations and residency selection having obtained the M.P.H. degree.

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Biomedical Graduate Studies

Biomedical graduate degrees, which are conferred by the Drexel University College of Medicine, are the Doctor of Philosophy degree (Ph.D.), the Master of Science degree (M.S.), several annotated and professional degrees, and the combined M.D./Ph.D.

Several disciplines and specific research areas in the biomedical sciences have become more and more narrow. Although the trend has led to major advances in many fields, the danger exists that students trained in those fields become so specialized in their knowledge that they miss the “big picture? of biomedical science—the interrelationships among disciplines and approaches to problems.

To meet that challenge and provide students with a more well-rounded education, the Office of Biomedical Graduate Studies of Drexel University has designed an intensive core curriculum. Consisting of courses in biochemistry, molecular biology, genetics, and cell biology, the core curriculum ensures that our students have a common, broad base of scientific knowledge. We believe that exposing students to such a multidisciplinary view makes them better prepared to think of problems in more global terms, giving them flexibility in their approaches to solving diverse research problems.

Core Curriculum
To ensure that all students who receive a Ph.D. or M.S. in a biomedical science from Drexel University have a common, broad base of scientific knowledge, they must complete the core curriculum in biomedical sciences. The core consists of three courses:

- Biochemistry
- Molecular Biology and Genetics
- Cell Biology

In addition to the core curriculum, all graduate students complete courses in biomedical ethics, statistics, and effective presentation skills, and must fulfill program-specific course requirements.

Doctor of Philosophy—Ph.D.
Ph.D. degree programs give students a comprehensive view of a field of knowledge and offer training in methods of research and scholarship in that field and closely related fields. All programs are interdisciplinary.

Ph.D. programs are offered in the following areas:

- Biochemistry
- Microbiology and Immunology
- Molecular and Cell Biology and Genetics
- Molecular Pathobiology

- Neuroscience
- Pharmacology and Physiology
- Radiation Sciences

Master of Science—M.S.
M.S. degree programs are designed to provide advanced technical and scientific study so that students are prepared to enter a specialized field or a doctoral program. They are research-based programs, and are offered in the following areas:

- Biochemistry
- Microbiology and Immunology
- Molecular and Cell Biology and Genetics
- Molecular Patholobiology
- Neuroscience
- Pharmacology and Physiology
- Radiation Sciences

A limited number of credits may be transferred from an accredited graduate institution under certain conditions. Once matriculated, a student must register each semester (except summer session) or be on an approved leave of absence. All work must be completed within five years from the date of matriculation. The M. S. degree has no residency requirements, but individual programs may stipulate them.

Students must pass a comprehensive examination and present a thesis based on original research work. The thesis must be acceptable in both scholarship and literary quality. The conduct and judgment of performance in the examination and the defense of the thesis are the province of the Advisory-Examination Committee.

A minimum cumulative grade point average of 3.0 is required of all candidates for graduation.

Biomedical Graduate Studies Curricula
All first-year students take core courses, including molecular biology and genetics, biochemistry, and cell biology. They are also expected to complete several research rotations in laboratories. After completing the first year, students select a thesis advisor and begin work on their research and thesis requirements for graduation.

Ph.D. candidates must submit a minimum of two manuscripts (publications from their research). The average amount of time required to complete the Ph.D. program is four to five years of full-time study. The master's program requirements are on average completed in two years of full-time study. Students pursuing a combined M.D./Ph.D. degree finish their thesis work within three to four years. All departments are well equipped to conduct modern research programs funded by extramural grants to the faculty.

Biochemistry
The Department of Biochemistry offers a challenging and broad-based graduate program of research and coursework leading to the M.S. or Ph.D. degree. Students must pass a preliminary exam at the end of the first year and a qualifying exam at the end of the second year. The aim of the graduate program is to educate scientists to identify, address, and solve biomedical problems at the molecular level. The themes of molecular structure, molecular mechanisms, and molecular regulation are recurrent throughout the diverse research areas

represented by the Biochemistry faculty. They include X-ray crystallography of membrane proteins, structure-based drug design, enzyme structure-function relationships, regulation of gene expression, cellular proliferation and the cell cycle, molecular oncology, and signaling mechanisms in yeast.

Microbiology and Immunology
The Department of Microbiology and Immunology offers graduate programs leading to the M.S. and Ph.D. degrees. In the first year, students spend much of their time completing the core curriculum as well as courses in immunology and microbiology. Students also rotate through three research laboratories to gain hands-on experience and to meet faculty, staff, and fellow graduate students. All students must pass a written and oral preliminary examination at the end of their first year, after which they select a research advisor and begin a research project.

Advanced-level courses in immunology, genetics, microbial physiology, molecular biology, microbial pathogenesis, mycology, and parasitology are offered in the second year. All students participate in departmental seminars and journal clubs each year. In their third year, Ph.D. candidates must pass a comprehensive exam, which consists of writing and orally defending a mock NIH grant proposal. Requirements for completing the Ph.D. degree include submitting a minimum of two manuscripts on the dissertation project for publication in internationally recognized, peer-reviewed journals. The average time to complete the Ph.D. is five years. The M.S. requirements are completed in two years of full-time study.

Molecular and Cell Biology and Genetics
This is an intensive, interdisciplinary, research-oriented program that offers both M. S., and Ph.D degrees. Its strength is derived from the combined research expertise of the faculty in various departments, including Neurobiology and Anatomy, Biochemistry, Microbiology and Immunology, Medicine, Surgery, Pathology, Pediatrics, and Pharmacology and Physiology. Students must pass a preliminary exam in the fall/winter of the second year and a qualifying exam in the spring/summer of the second year. In the M.S. program, the focus is on strengthening the student’s grasp of molecular biology, genetics, and biotechnology and on providing a knowledge of research methods available in the fast-expanding field.

Molecular Pathobiology
This program gives students a thorough education in contemporary experimental pathology and prepares them for careers in medical translational research and biotechnology. Students entering without advanced standing should complete the M.S. program in two to three years and the Ph.D. program in four to five years.

In addition to the core curriculum, students take human pathology and elective courses in physiology, cancer biology, genetics, and immunology. All Ph.D. students must pass a preliminary exam, consisting of a comprehensive research proposal, at the end of their first year of study, a qualifying research literature review in their third year, and a written and oral defense of a thesis proposal to proceed with research. A successful thesis defense completes the requirements for the M.S. and Ph.D. degrees.

Neuroscience
To meet the need for research scientists with broad backgrounds in neuroscience, the University offers the interdepartmental neuroscience program leading to the M. S. and Ph.D. degrees. One of the few programs of its kind in the area, it gives students an opportunity to gain interdisciplinary research training. Participating faculty include members of the departments of Neurobiology and Anatomy, Pathology and Laboratory Medicine, Pharmacology and Physiology, and

Neurology. Students must pass a comprehensive exam at the end of the second year and present their thesis proposal at the beginning of the third year.

The Ph.D. program educates students to conduct independent research and to teach in the neurosciences. The program includes two years of coursework followed by original research leading to a dissertation. The M.S. program gives students a broad background in neuroscience and the techniques used in neuroscience research. Students who wish to continue their graduate training after the M.S. degree may apply to the Ph.D. program, and their credits may be applied to the doctoral program.

Pharmacology and Physiology
Students in both the Ph.D. and M.S. programs begin their coursework with a core curriculum in biomedical sciences, and immediately start laboratory rotations. Intensive graduate-level pharmacology and physiology courses round out the core programmatic courses. Specialization in ion channel physiology, smooth-muscle physiology, neuropharmacology, behavioral pharmacology, and signal transduction processes may involve the taking of several elective courses. Each program requires the defense of a thesis based on original research.

The Ph.D. program, requiring a minimum of four years in full-time study, focuses on educating students to become independent researchers and teachers in pharmacology and physiology.

The M.S. program, requiring two years of full-time study, provides a broad knowledge and technical expertise in pharmacology and physiology, allowing graduates to become partners in research in either an academic or an industrial environment. Students who wish to continue their graduate studies after the M.S. degree may apply to the Ph.D. program, and their course credits may be applied to the doctoral program.

Radiation Sciences
The Radiation Sciences program offers M.S. and Ph.D. degrees to prepare students who have backgrounds in biology, physics, or the medical sciences for careers in radiation oncology or nuclear medicine. The M.S. program places emphasis on developing a strong theoretical background in the radiation sciences with training in laboratory research and exposure to the clinical dimensions of radiation oncology. The Ph.D. program prepares students for independent research and problem-solving in radiation sciences.

Graduates may seek careers as medical physicists, radiopharmaceutical scientists, radiobiologists, clinical physicists, or radiation safety specialists in areas such as hospitals, universities, public and private industry, and various government laboratories and agencies. Depending on their career paths, graduates may be required to pass national board examinations. The curriculum includes laboratory and clinical work in radiation physics; external beam radiation dosimetry; internal dosimetry; shielding and design; radiation safety and quality assurance; radiation biology; radiopharmaceutical science; nuclear imaging, and algorithms for radiation transport, image processing, and three-dimensional graphics. Students must pass a preliminary exam at the end of the second year.

Professional Master’s Degrees
The Biomedical Graduate Studies program offers three master’s programs leading to professional degrees. The programs provide instruction in professional areas and often serve as preparation for the practice of these professions. In a few fields, the professional degree is a prerequisite for licensure to practice.

The Medical Science Programs in Biomedical Graduate Studies offers the Interdepartmental Medical Science (IMS) and the Medical Science Preparatory (MSP) programs in the first year. These programs are designed to enhance credentials for application to medical school. Both programs offer a certificate to academically qualified students in one year or an annotated master's degree after two years. Degree programs offered are:

• Interdepartmental Medical Science (M.M.S.)

•Medical Science Preparatory (M.B.S.)

The third professional master's degree program offered by Biomedical Graduate Studies is the Master of Laboratory Animal Science (M.L.A.S.) degree. This two-year program is designed for students with a bachelor's degree in animal science or a related field seeking advanced career positions in laboratory animal science. The program is equally valuable for students who wish to attend veterinary school.

Although the requirements for the degrees at the master's level are often comparable to those for the M.S. degree, each program has its own requirements. Professional degrees have no residency requirements, but individual programs may stipulate them. Some programs do not require research.

M.D./Ph.D.
The College of Medicine has a funded M.D./Ph.D. program for highly qualified students. The program trains individuals in the fundamental clinical aspects of medicine and offers advanced training in a specific field of research.

Students usually need seven or eight years to complete both degrees. All work must be completed within nine years of the date of matriculation.

Curriculum
The M.D./Ph.D. program offers an exciting and intellectually challenging course of study that generally can be completed in seven years.

During the first two years, students follow the basic medical preclinical curriculum, which includes an expanded Introduction to Clinical Medicine course. During this period, students rotate through a number of research laboratories and, in consultation with members of the M.D./Ph.D. Advisory Committee, select a mentor for research training in any of the disciplines offering the Ph.D. degree.

The next three to four years focus on individualized advanced coursework, thesis research, and seminars.

They culminate in the thesis defense. Students also attend clinical seminars and presentations to maintain their awareness of clinical issues. The final two years involve clinical rotations and electives.

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Interdepartmental Medical Science Program

The Interdepartmental Medical Science (IMS) program is a special graduate post-baccalaureate program, established in 1981 within the MCP Hahnemann University School of Medicine (now Drexel University College of Medicine). The program is designed for college graduates who have already taken the premedical course requirements of most medical schools but seek additional training to become more competitive applicants to schools of medicine. It is “interdepartmental? because students take courses within several departments. Courses are taken in biochemistry, pharmacology, microanatomy, immunology, physiology, nutrition, neuroscience, and bioethics.

Applicants include students who were wait-listed for medical school acceptance, students who were late in the application cycle, students who need to improve or enhance their academic credentials, and students who would like a year in a medical school setting to determine whether or not medicine is the right career choice for them. Applicants should already have competitive MCAT scores, generally an overall of 27 or better. An undergraduate overall and math/science GPA of 3.00 is generally required.

Students attend the program full time, earning either a post-baccalaureate certificate, if they successfully complete the program in one year, or a Master’s of Medical Science degree, if they successfully complete the IMS program and continue on for a second year.

The students take six major medical school courses in conjunction with the College of Medicine’s first-year class. They are graded according to the mean of the College of Medicine class. This permits medical school admissions committees to directly evaluate the students’ competence compared with those already in medical school. It gives students the opportunity to test their preparation and motivation. Students who earn B’s or better in the first semester of the IMS program, and who have applied to the Drexel University College of Medicine, are granted a guaranteed interview with the College of Medicine. The guaranteed interviews are conducted in the spring semester.

During the past 20 years, 60 to 85 percent of the students who completed the program successfully (B’s or better in all courses) were accepted into U.S. medical schools after the first year. An additional 10 to 20 percent were accepted after completing two years and earning their master’s degree. The overall two-year acceptance rate for each class of students who received B’s or higher in all courses ranges from 80 to 95 percent for all years. More than 800 students have been accepted to more than 80 medical schools during these 20 years. In addition, students who have completed the program have also chosen to go into professions other than medicine. They have gone into schools of dentistry, optometry, and veterinary medicine and other graduate programs.

Curriculum
The program requirements consist of seven courses, six of which are taken in conjunction with the University’s first-year College of Medicine class: Medical Biochemistry, Cell Biology and Microanatomy, Medical Physiology, Medical

Neuroscience, Biomedical Nutrition, and Basic and Clinical Immunology. The seventh course is a medical ethics course titled Medicine and Society. The College of Medicine lectures are simulcast to the Center City Hahnemann Campus from the Queen Lane Medical Campus, where the College of Medicine is located. The lectures are also videotaped and made available to the students in the Center City Library. Course conferences and laboratory components for the IMS students are conducted in small groups with medical faculty at the Center City Hahnemann Campus.

The IMS curriculum allows both exposure to College of Medicine lectures and individual attention in small group conferences. IMS students take the same examinations and are evaluated based on the performance of the first-year College of Medicine students.

Those who have at least a 3.00 GPA in the IMS program and wish to receive a graduate degree may continue for another year of training to complete the requirements for the Master of Medical Science (M.M.S.) degree that the program offers. The M.M.S. degree requires research (non-thesis). Students in the MMS program also take one second-year College of Medicine course along with the College of Medicine ‘s second-year class.

Students may choose to apply to one of the research-based and thesis-requiring programs in the biomedical sciences offered at Drexel University. Students may also apply to one of the thesis or non-thesis M.S. or Ph.D. programs in biomedical engineering or biomedical sciences in the School of Biomedical Engineering, Science, and Health Systems at Drexel University. Acceptance into any of the graduate programs and transfer of IMS course credits are at the discretion of the individual program.

Medical Science Preparatory Program
The Medical Science Preparatory (MSP) program is a one-year certificate program designed for students needing to enhance their credentials for application to medical school by helping to improve their science background and MCAT scores. Applicants to the MSP program must have already completed the premedical science courses required of most medical schools: a year of general biology, chemistry, organic chemistry, and physics, including laboratories. An overall and math/science GPA of at least a 3.00 is preferred.

Students who successfully complete the MSP program, earning a 3.00 graduate GPA and receiving a total score of 27 on the April MCAT, are guaranteed admission into the IMS program for the succeeding year. Those who complete the degree requirements during the second year receive a Master of Biological Science (M.B.S.) degree. Students who do not earn either the 3.00 graduate GPA or the 27 on the MCAT may receive admission into a modified version of the IMS program. Students in the modified program may still earn their master’s degree, but they are not permitted to take all of the courses allotted for the IMS program. Students who have completed the MSP program successfully and do not wish to continue on for a second year earn a post-baccalaureate certificate of program completion.

Curriculum
Students in the MSP program take four graduate-level courses in anatomical, biochemical, pharmacological, and physiological science. Also included are undergraduate-level review courses in physics and chemistry, a laboratory course, and a community dimensions course. In addition, there are weekly reviews in the verbal reasoning, biological science, and physical science sections of the MCAT. Mock MCATs are given throughout the year. Students are required to take the

April MCAT.

Evening Post-Baccalaureate Pre-Medical Program
The Evening Post-Baccalaureate Pre-Medical (EPBPM) program is a two-year certificate program designed for non-science college graduates who wish to pursue a career in medicine, dentistry, podiatry, veterinary medicine, chiropractic, or other allied health professions. Students take the rigorous science prerequisites of health professional schools during the evening hours so that they can continue to maintain their daytime professions. Linkage programs exist with Drexel College of Medicine and the University of Medicine and Dentistry New Jersey Robert Wood Johnson School of Medicine. The linkage programs help facilitate students' entry into medical school a year earlier than would occur on a traditional track. Students who successfully complete the program earn a certificate of program completion at the end of the two years.

Curriculum
Prerequisites for the program include a bachelor's degree, a minimum of six credits of English and the behavioral sciences and three credits of college-level mathematics, a minimum SAT score of 1100, and an undergraduate GPA of 3.00. Students in the EPBPM program take a year of general biology with lab, general chemistry with lab, organic chemistry with lab, and general physics with lab. The program culminates with a preparatory course for the Medical College Admission Test (MCAT) or other necessary admissions test for application to a professional school. In addition, the program administrators provide academic, career, and application advisement.

Faculty Advisors and Program Directors
Each student in the IMS program is assigned a faculty advisor who writes letters on his or her behalf and provides advice on his or her medical school application.

Thomas Conover, Ph.D. *(University of Rochester), Professor, Biochemistry*

Dennis DePace, Ph.D. *(State University of New York at Buffalo), Associate Professor, Neurobiology and Anatomy*

Jacqueline Emrich, Ph.D. *(Hahnemann University), Associate Professor, Radiation Oncology*

Denise Ferrier, Ph.D. *(Bryn Mawr College), Associate Professor, Biochemistry*

Cheryl Hanau, M.D. *(Jefferson Medical College), Associate Professor, Pathology and Laboratory Medicine*

Alan J. Haroian, Ph.D. *(St. Louis University), Associate Professor, Arts and Sciences*

Michael C. Kennedy, Ph.D. *(University of Rochester), Professor and Vice Chairman, Arts and Sciences*

Robert Koenigsberg, D.O., F.A.O.C.R. *(Philadelphia College of Osteopathic Medicine), Associate Professor, Radiologic Sciences*

Kirsten Larson, Ph.D. *(Mayo Clinic), Assistant Professor, Microbiology and Immunology*

Robert J. McKenzie, Ph.D. *(Washington State University), Associate Director of Medical Science Programs and Assistant Professor, Biochemistry*

R. Peter Meyer, Ph.D. *(Temple University), Associate Professor, Arts and Sciences*

S.N.S. Murthy, Ph.D. *(Philadelphia College of Pharmacy and Science), Professor of Medicine, and Associate Vice President for Research Compliance, Office of Research*

Robert Nichols, Ph.D. *(Stanford University), Associate Professor, Pharmacology and Physiology*

Constance Perry, Ph.D. *(State University of New York at Buffalo), Associate Professor, Humanities and Science Programs*

Robin R. Preston, Ph.D. *(University of Nottingham), Associate Professor, Pharmacology and Physiology*

Donna Russo, Ph.D. *(Hahnemann University), Associate Professor, Microbiology and Immunology*

Kimberly Sabadish, M.D. *(Hahnemann University), Clinical Associate Professor, Medicine*

Jed S. Shumsky, Ph.D. *(University of Pennsylvania), Research Assistant Professor, Neurobiology and Anatomy*

Janet Smith, Ph.D. *(Cornell University), Associate Professor, Neurobiology and Anatomy*

Gerald Soslau, Ph.D. *(University of Rochester), Director of Medical Science Programs and Professor of Biochemistry*

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Master of Laboratory Animal Science Program

Drexel University is the only institution in the nation that offers the Master of Laboratory Animal Science (M.L.A.S.) degree. This two-year program is designed for persons who have a bachelor's degree in animal science or a related field, such as biology, zoology, or preveterinary studies. Students receive preparation for advanced career positions in laboratory animal science.

The program is equally valuable for persons who wish to attend veterinary school, particularly those with a career interest in laboratory animal medicine. It gives them an opportunity to demonstrate their ability in graduate school before applying or reapplying to veterinary school. Approximately 70 percent of M.L.A.S. students who apply to schools of veterinary medicine are accepted.

M.L.A.S. students may take some elective courses at the University of Pennsylvania's School of Veterinary Medicine.

Curriculum

The basic program requires two years of full-time study. The final semester is spent working with laboratory animals at an off-campus research facility. No thesis is required. The following schedule is an example. The curriculum is subject to change.

Typical First Year

Fall		Credits
MLAS 505	**Pathogenesis of Infectious Diseases**	3
MLAS 510	**Clinical Orientation to Laboratory Animal Facilities**	1
MLAS 512	**Basic Pathology**	3
MLAS 545	**Fundamentals of Histology**	2
MLAS 546	**Special Topics in Anatomy**	4
PHYS 503	**Physiology**	4

Spring		
MLAS 520	**Financial Management in Laboratory Animal Science**	3
MLAS 521	**Architecture, Engineering, and Planning of Laboratory Animal Facilities**	4
MLAS 523	**Organizational Management I**	3
MLAS 529	**Molecular Genetics**	2
MLAS 535	**Biology and Care of Laboratory Animals**	4
MLAS 547	**Special Topics in Anatomy Laboratory**	2

Typical Second Year

Fall		Credits
MLAS 501	**Laboratory Animal Science Journal Club**	1
MLAS 524	**Organizational Management II**	3
MLAS 530	**Epidemiology and Biostatistics in Laboratory Animal Science**	2
MLAS 536	**Animal Models in Biomedical Research**	1
MLAS 606	**Clinical Laboratory Techniques and Concepts**	1
MLAS 610	**Diseases of Laboratory Animals**	3
PHRM 512	**Drug Actions and Uses**	3
RADS 500	**Bionucleonics**	3

Spring		
MLAS 801	**Laboratory Animal Practicum (off campus)**	15

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The School of Biomedical Engineering, Science, and Health Systems

The School of Biomedical Engineering, Science, and Health Systems (formerly the Biomedical Engineering and Science Institute, founded in 1961) is a nationally recognized center of research and graduate education offering multidisciplinary graduate instruction and research on a full- and part-time basis. The School offers Master of Science, Master of Science with areas of specialization, and Ph.D. programs in biomedical engineering and biomedical science.

- Biomedical Engineering
- Biomedical Science
- Faculty
- Facilities

The School is the beneficiary of a major endowment that sponsors chair professorships and fellowships. Research and educational strengths include biosensors, biomedical ultrasound, biomedical imaging, biomedical systems and signal processing, biomechanics, biomaterials, tissue and cellular engineering, neuroengineering, cardiovascular systems, and bioinformatics and computational biomedicine.

Our faculty includes individuals with specialties in engineering, physics, mathematics, biostatistics, life sciences, medicine, and other clinical disciplines. Of the 93 Drexel faculty members associated with the School, 20 hold primary appointments in the School and 73 have joint appointments. Some 52 adjunct faculty members from regional institutions and industry also participate in the research and academic programs of the School.

In addition to the curriculum offered by the School, various departments at Drexel University offer courses that are suited for students in biomedical engineering and biomedical science. These courses offer advanced knowledge needed for industrial careers, health professions, graduate research, or careers in highly specialized fields.

Metropolitan Philadelphia has one of the nation's highest concentrations of medical institutions and pharmaceutical, biotechnology, and medical devices and systems industry. In 1998, Drexel University entered into a management contract with the country's largest medical school, MCP Hahnemann University. Major collaborative efforts are focused on neuroengineering, cellular and tissue engineering, cardiovascular engineering, minimally invasive surgery, and complex physiological systems. The School has also formed an academic alliance with Thomas Jefferson University and has entered into a joint initiative in bioinformatics with the Coriell Institute for Medical Research and the Windber Research Institute. These initiatives provide students with ample opportunities in basic and clinical research as well as innovative academic programs.

Applicants to the graduate program must meet the requirements for admission to graduate studies at Drexel University. Candidates for degrees in the School of

Biomedical Engineering, Science, and Health Systems are required to maintain academic standards applicable to all graduate students at Drexel University.

Program Objectives

The overall objective of the graduate programs offered by the School of Biomedical Engineering, Science, and Health Systems is to provide multidisciplinary curricula with an instructional core and research opportunities for students. Graduate biomedical engineering students are typically individuals with undergraduate degrees in engineering, physical sciences, or mathematics. The core curriculum provides the necessary training in life and medical sciences, modeling and simulation, and biomedical engineering applications to allow students to apply their engineering skills and perspective to solve current problems in biology and medicine. Areas in which students may focus their advanced studies and research attention include biomechanics and biomaterials, cellular and tissue engineering, biomedical sensing and imaging, human factors and performance engineering, neuroengineering, and bioinformatics. Students without an academic background in engineering or physical science who wish to enter the biomedical engineering program may enroll in the Crossover Program.

The core courses in the biomedical science program are designed to educate life science students in quantitative analysis, mathematical modeling, systems analysis, and fundamental computational and informatics skills. Students are then encouraged to combine their knowledge of the life sciences with their newly acquired analytical skills to focus in such areas as biostatistics, genome science, and systems biology.

Financial Assistance

Financial support for qualified students pursuing studies toward the M.S. and Ph. D. degrees is available in the form of research assistantships, teaching assistantships, and fellowships. Calhoun Fellowships are supported by the School's Calhoun Endowment. The Calhoun Fellowship provides tuition and stipend for the first year and is renewable depending on the student's academic and research performance.

To be considered for a fellowship, students must submit an original copy of GRE scores along with all their application materials. The application deadline is February 1 for the following academic year. Applicants are notified by April 30 each year.

Dean's Fellowships are available for outstanding applicants to the School when other forms of financial assistance are not available. These fellowships provide 40 percent of a student's tuition (excluding the general fee) for the first term and are renewable depending on the student's academic performance. A minimum GPA of 3.5 is required for continued support. To be considered, applicants:

1. Must be seeking full-time study at either the master's or Ph.D. level

2. May not receive any other form of assistantship or fellowship from the University

3. Must have a GPA of 3.5 or better in their bachelor's program

4. Must submit GRE scores

5. Must have a TOEFL score of 600 or better (for international students)

For further assistance, please contact the Office of Graduate Admissions.

Master of Science Programs
The School of Biomedical Engineering, Science, and Health Systems administers M.S. programs in biomedical engineering and biomedical science. The biostatistics program is offered as a specialization in biomedical science. Areas of specialization for the biomedical engineering program include biomechanics and biomaterials, cellular and tissue engineering, biomedical sensing and imaging, human performance engineering, neuroengineering, and bioinformatics. Areas of specialization for the biomedical science program include biostatistics, genome science, systems biology, and bioinformatics.

The School requires the completion of a set of core courses as part of the University requirement for the M.S. degree. In total, students must take a minimum of 45 quarter credits and complete a master's thesis to obtain an M.S. degree. This program of study usually takes approximately two years to complete.

A nonthesis option is available to students who do not wish to engage in research activity leading to a master's thesis. Students who take this option are required to complete an additional course sequence for a minimum of 6 credits in a technical elective and pass a comprehensive examination. Students taking this option are ineligible for financial support in the form of research, graduate, or teaching assistantships.

Doctoral Programs
Academically superior students with training in engineering, life sciences, physical sciences, and/or mathematics and individuals with academic or professional degrees in the medical science disciplines will be considered for admission to the Ph.D. program.

To be awarded the Ph.D. degree, students must complete 90 graduate credits; fulfill a one-year residency requirement; and successfully pass the qualifying examination, the candidacy examination, and a Ph.D. dissertation and oral defense. Students who have already obtained a master's degree may apply as post-master's Ph.D. candidates. All prior coursework must have a grade of B or higher. If approved, the master's degree may count as 45 of the 90 credits required for the Ph.D.

The qualifying examination is intended to test students' general knowledge of biomedical engineering and science. It is a written examination that covers the basic knowledge expected of students wishing to proceed toward a Ph.D. Biomedical engineering students are also expected to demonstrate physical science aptitude and preparation. Biomedical science students are expected to demonstrate aptitude and preparation in life sciences, as well as an understanding of mathematics and basic principles of physical science.

After passing this examination, students are eligible to take the candidacy examination, which is administered by a committee convened to examine the student's preparation and ability to undertake dissertation research.

Career Integrated Education
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 Career Integrated Education (CIE), 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 CIE course coinciding with their term of employment. Students gain work experience while earning salaries. It is important to note that the CIE program does not guarantee a job. It is a market-driven process for the candidates as well as employers. CIE provides the tools and contacts; the student must qualify for the job on the basis of merit, qualifications, and skills. Further information on the CIE program is available at the Career Management Center.

Biomedical Engineering

Biomedical engineering is concerned with the application of engineering and science methodologies to the research and development of medical devices and systems, the analysis and solution of biological and physiological problems, the delivery of health care, and industrial applications. The biomedical engineer requires the analytical tools and broad physical knowledge of modern engineering and science, fundamental understanding of biological and physiological systems, and familiarity with recent technological breakthroughs.

The biomedical engineering program provides training and research experience in engineering, computational and physical sciences, biology, physiology, and medicine. Engineers, physical scientists, and mathematicians entering the program receive advanced training in engineering and life sciences. Life scientists entering the program are first required to complete an accelerated Crossover Program that provides the necessary competence in mathematics, physics, and engineering. This curriculum usually prolongs the duration of the degree program.

The M.S. program is designed around a core set of required courses that provides students with a unified level of knowledge. Elective courses and thesis research enable students to develop their chosen specialties and to pursue their individual professional goals. Multidisciplinary research activities form an integral part of both the M.S. and Ph.D. programs.

Areas of Specialization
Concentration areas in biomedical engineering include:

Biomechanics and Biomaterials
Biomechanics and biomaterials is designed to meet two objectives: to acquaint students with the responses of biological tissues to mechanical loads as well as with the mechanical properties of living systems, and to familiarize students with natural tissues and the implants designed to replace them.

Cellular and Tissue Engineering
The concentration in tissue engineering educates students in the emerging field of cellular and tissue engineering. It is offered jointly with the Department of Chemical and Materials Engineering. The program builds on the fundamental knowledge of cellular biology and natural and synthetic biomaterials. Specialized courses developed for the program include Cellular Biomechanics, Advanced Scaffold Design and Manufacturing, Factor-Mediated Tissue Engineering, Biosurfaces, Computer-Aided Tissue Engineering, and Integrated CAD/CAM for Tissue Engineering Applications.

Biomedical Sensing and Imaging
The biomedical sensing and imaging curriculum focuses on the theoretical and practical issues related to biosensor design, machine vision, image processing and analysis, and signal processing associated with such medical applications as ultrasound, optical, magnetic resonance, and autoradiographic imaging.

Biomechanics and Human Performance Engineering
Biomechanics and human performance engineering provides students with the background and skills needed to create work and living environments that improve

human health and enhance performance. Courses in this area of specialization cover biomechanics, motor systems, evolutionary medicine, chronobiology, human-machine interface, human nutrition, toxicology, risk assessment, social factors in health and aging, and environmental design.

Neuroengineering
Neuroengineering is broadly defined to include the modeling of neural and endocrine systems, neural networks, neurocontrol, neurobiotics, neuroprosthetics, complexity in physiological systems, and evolutionary influences in biological control systems.

Bioinformatics
The development of an integrated approach to understanding the development of diseases and the complex dynamic that underlies molecular and cellular functions has not yet occurred. Systems engineering techniques, such as pattern recognition, system modeling, and signal processing, will be necessary tools in the development of molecular, cellular, and clinical fingerprints of complex diseases and as such will have strong impacts on the development of new therapies. As a result, the School of Biomedical Engineering, Science, and Health Systems has created and expanded interdisciplinary programs that build on computer sciences, mathematics, biomedical science, and biomedical engineering that are necessary for developing the field of bioinformatics.

Bioinformatics is an interdisciplinary field that aims to integrate large bodies of information for the purpose of new biological insights and medical discoveries. The information considered largely involves genes and their products. Bioinformatics databases now available include sequence and identity of genes, mapping of genes onto chromosomes, homology relationships between genes of different species, protein sequences, their 3D configurations, and the identity and function of various proteins in metabolic and signaling pathways. When linked with biomedical research literature, biomolecular databases provide valuable insights into the inner workings of living cells as well as the distinct molecular profiles of various disease states.

The need for bioinformatics in biomedical sciences and professions has increased tremendously with the recent transformation of biology from a discipline aimed at determining gene identity and function, one at a time, to a science in which the activities of thousands of genes (proteins) are quantified all at once in normal and perturbed states. The interpretation of the newly emerging large-scale data requires a system approach identifying the elements and flow diagrams of the gene and protein networks underlying the behaviors of cells and tissues. Drexel’s bioinformatics program benefits from the University’s internationally recognized strength in biomedical system engineering and information systems. In addition, Drexel has established ongoing bioinformatics partnerships with the Coriell Institute for Medical Research, dedicated to the study of genetic causes of human diseases, and the Windber Research Institute in Windber, Pennsylvania, one of the most comprehensive genomic and proteomic laboratories in the country.

Drexel’s bioinformatics program promotes an integrated bioinformatics approach in which intelligent database systems are used for early detection, accurate classification, and subsequent treatment of complex diseases such as cancer.

Crossover Program
Students without an academic background in engineering, physical sciences, or mathematics who wish to enter the biomedical engineering program may enroll in an accelerated curriculum designed to fulfill the requirements for admission. The program is a combination of undergraduate and graduate courses offered by the School or by the University’s other engineering and science departments. It is structured to bring students up to a level that conforms to the Accrediting Board for Engineering and Technology (ABET) requirements for engineering education. The

program usually requires two additional years of full-time study. No graduate credit is given for the undergraduate courses. For specific requirements, contact the graduate advisor for biomedical engineering or the Director of the School.

Curriculum

Courses		Credits
BIO 501	**Biochemistry Laboratory**	2.0
BMES 501	**Medical Sciences I: Cellular and Tissue Biology**	4.0
BMES 502	**Medical Sciences II: Organ-Level Physiology**	4.0
BMES 503	**Medical Sciences III: Neural and Endocrine Control Systems**	4.0
BMES 671	**Biosimulation and Virtual Instrumentation**	2.0
BMES 680	**Special Topics: Biosimulation II**	2.0
BMES 864	**Seminar I**	0.0
BMES 864	**Seminar II**	0.0
BMES 864	**Seminar III**	0.0
Three of the following courses		**9.0**
BMES 551	**Biomedical Signal Processing**	
BMES 555	**Chemical Engineering Fundamentals in Biology and Medicine**	
BMES 561	**Introduction to Systems Analysis in Biology**	
BMES 621	**Medical Imaging Systems I**	
BMES 641	**Biomedical Mechanics I**	
BMES 651	**Fundamentals of Biosensors I**	
ENVR 501	**Chemistry of the Environment**	
INFO 503	**Introduction to Information Systems Analysis**	
Electives (selection varies by specialization)		**18.0**
BMES 897	**Research**	
BMES 898	**Master's Thesis***	

***The research for the thesis may include work carried out during an internship.**

Biomedical Science

The graduate program in biomedical science educates students whose undergraduate education is in basic life sciences (e.g., biology or biochemistry) or paramedical disciplines (e.g., nursing, physical therapy, or medical technology) in quantitative analysis, mathematical modeling, fundamental computing skills, and informatics. Students in biomedical science achieve depth in the modeling of living systems and biomedical information processing and display.

Students who graduate from the biomedical science program often continue clinical training in medicine, dentistry, or veterinary medicine; pursue further graduate study toward the Ph.D. degree; or work in the field.

Areas of Specialization

Biostatistics is currently offered as a specialization in biomedical science. The program responds to the demand for life scientists with advanced training in biostatistics and experimental design.

Two new specialization areas under development are genome science and systems biology. Genome science is designed to provide students with advanced training in biochemistry, recombinant DNA technology, and information science. Systems biology trains students to deal with organisms as systems and includes coursework in biochemistry, biological control systems, cell biology, and neural networks.

Curriculum

Courses		Credits
BIO 643	**Modeling Methods in Biology II**	3.0
BMES 505	**Mathematics for Biomedical Science I**	3.0
BMES 506	**Mathematics for Biomedical Science II**	3.0
BMES 507	**Mathematics for Biomedical Science III**	3.0
BMES 510	**Biomedical Statistics**	3.0
BMES 511	**Principles of Systems Analysis Applied to Biomedicine I**	3.0
BMES 512	**Principles of Systems Analysis Applied to Biomedicine II**	3.0
BMES 515	**C Programming for Life Scientists**	3.0
BMES 681	**Physics of Living Systems I**	3.0
BMES 864	**Seminar I**	0.0
BMES 864	**Seminar II**	0.0
BMES 864	**Seminar III**	0.0

Electives		18.0
BMES 897	**Research**	(max. 6.0)
BMES 898	**Master's Thesis**	

Additional courses in biostatistics		Credits
MATH 510	**Applied Probability and Statistics I**	3.0
MATH 511	**Applied Probability and Statistics II**	3.0
MATH 512	**Applied Probability and Statistics III**	3.0
STAT 620	**Applied Multivariate Analysis**	3.0
STAT 628	**Regression and Correlation Analysis**	3.0
STAT 632	**Multivariate Discrete Analysis**	3.0
STAT 636	**Experimental Design**	3.0

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 sources — a combination of talents crucial to organizations competing in the global marketplace. Students graduating with the M.S. 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 in the evening.

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.

Degree Requirements
The M.S. 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. Typical elective areas of specialization are listed below.

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.

Dual-Degree Requirements
Students may simultaneously pursue the M.S. in engineering management and another degree. Students must satisfy program requirements for each degree, with a maximum of 15 credits transferred from one program to the other. (The M.S. 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.

Career Integrated Education Program
The Career Integrated Education program (graduate intern or co-op program) is available to master's-level engineering management students. The opportunity to spend six months in industry in engineering management provides a significant opportunity for the engineer in transition to management. Through Drexel's Career

Management Center, students can explore new career directions. This program requires 6 additional credits, 3 for each term in industry.

Engineering Management on the Web

The Engineering Management Program offers courses from the regular curriculum over the Internet. Students can currently obtain a Graduate Certificate and soon their master's degree by attending classes on the web. Though the instruction follows the on-campus schedule for lecture material, homework, projects, and examinations, students have flexibility in receiving lecture material and scheduling their time.

Curriculum

Core 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 535	**Financial Management I**	3.0
EGMT 536	**Financial Management II**	3.0
EGMT 537	**Problems in Engineering Administration**	3.0
EGMT 572	**Managerial Statistics II***	3.0
EGMT 573	**Operations Research I**	3.0
EGMT 574	**Operations Research II**	3.0
EGMT 581	**Problems in Human Relations**	3.0

***EGMT 572 requires as a prerequisite EGMT 571 or permission of the instructor. Students may take EGMT 571, but credit for it is not applicable to the degree.**

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

Areas of Specialization

Typical or suggested areas of specialization or major course groupings are presented below as examples. These are only sample programs; students may develop their own elective programs by submitting a plan of study for approval of the program director.

Construction Management

Please see the department for more information on this specialization.

Financial Management

Courses		Credits
FIN 622	**Financial Institutions and Markets**	3.0
FIN 624	**Risk Management**	3.0
FIN 626	**Investment Management**	3.0
FIN 628	**Capital Budgeting**	3.0
FIN 642	**Business Conditions and Forecasting**	3.0

Industrial Relations

Courses		Credits
EGMT 652	**Engineering Law**	3.0
HRMT 622	**Human Resource Administration***	3.0
	Wages and Labor Markets**	3.0
HRMT 636	**Collective Bargaining***	3.0
	Seminar in Manpower Management**	3.0

***Prerequisite: HRMT 311, a first-year business course not creditable to the degree.**

****See department for course number and description.**

Quality and Manufacturing Management

Courses		Credits
EGMT 680	**Special Topics: Quality Planning for Engineers I**	3.0
EGMT 680	**Special Topics: Quality Planning for Engineers II**	3.0
EGMT 680	**Special Topics: Manufacturing Management for Engineers**	3.0
FIN 628	**Capital Budgeting**	3.0
OPR 626	**System Simulation**	3.0

R&D Management

Courses		Credits
EGMT 605	**R&D Management I**	3.0
EGMT 606	**R&D Management II**	3.0
EGMT 652	**Engineering Law**	3.0
EGMT 680	**Special Topics: Project Management for Engineers**	3.0
PSY 614	**Problem-Solving and Creativity**	3.0

Technical Marketing

Courses		Credits
EGMT 607	**Marketing for Engineers**	3.0
MKTG 622	**Buyer Behavior**	3.0
MKTG 650	**Marketing Management: Cases and Problems**	3.0
MKTG 652	**Marketing Information: Management and Research**	3.0
MKTG 790	**Seminar in Marketing Problems**	3.0

Scheduling

All courses are offered in the evening. Core courses are offered each year in

accordance with departmental scheduling. The following is a typical three-year program of study, although most students spread the program over a longer period of time. Elective courses are offered in accordance with demand and may not be available every year. Scheduling information for the major elective sequences is available from the department.

First year

EGMT 501	**Engineering Management I (fall)**
EGMT 502	**Engineering Management II (winter)**
EGMT 504	**Communications (spring, summer)**
EGMT 531	**Economics for Engineering Management (fall)**
EGMT 572	**Managerial Statistics II (winter)***

Second year

EGMT 535	**Financial Management I (winter)**
EGMT 536	**Financial Management II (spring)**
EGMT 537	**Problems in Engineering Administration (spring)**
EGMT 573	**Operations Research I (winter)**
EGMT 574	**Operations Research II (spring)**
EGMT 581	**Problems in Human Relations (fall)**

Third year

Elective sequence: 15 credits from the following, or approved courses from other departments	
EGMT 605	**R&D Management I (fall)**
EGMT 606	**R&D Management II (winter)**
EGMT 607	**Marketing for Engineers (spring)**
EGMT 652	**Engineering Law (fall)**
EGMT 680	**Special Topics: Quality Planning for Engineers I (fall)**
EGMT 680	**Special Topics: Quality Planning for Engineers II (winter)**
EGMT 680	**Special Topics: Project Management for Engineers (summer)**
EGMT 680	**Special Topics: Materials Management for Engineers (summer)**
EGMT 799	**Research (all terms)**
or	
EGMT 898	**Thesis (all terms)**

Master of Science in Software Engineering

General Information

Drexel University's Master of Science in Software Engineering (M.S.S.E.) 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.

The M.S.S.E. is a multidisciplinary degree sponsored by the Colleges of Arts and Sciences, Engineering, and Information Science and Technology. The program, drawing on the strengths of existing Drexel programs in computer science, engineering, and information science and technology, provides a curriculum that encompasses behavioral, managerial, and technical aspects of software engineering and attempts to synthesize—rather than differentiate—disciplinary paradigms and themes. The program is appropriate for students interested in a wide range of application domains.

Program of Study

All students in the M.S.S.E. 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 build 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 Career Integrated Education (CIE) program. The average time to complete the master's degree is two years of full-time study or three years of part-time study.

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.*
- *Applicants must have an acceptable score on the Graduate Record Exam (GRE). An applicant's undergraduate and/or graduate record may justify waiver of this requirement. For students pursuing full-time study in the engineering track, the General (Aptitude) Test of the GRE is required.*
- *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.

After consultation with an academic advisor, students found to be deficient in one or more of the above areas will be required to take up to three foundation courses (these will not count toward the degree) to prepare them for admission to the M.S.S. E. 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.

Degree Requirements

Degree requirements vary by track. All students take the required six core courses (20 credits).

Core Courses

Core courses cover topics that are essential for the practicing software engineer. Each of the three Colleges offers two specifically designed courses.

Please see the course descriptions for information about each course.

Computer science courses		**Credits**
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**	4.0
INFO 638	**Software Project Management**	4.0

Tracks

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

Information Science and Technology Track

Track Coordinator: Dr. Gregory Hislop, 215-895-2179, hislop @ 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 systems values, such as the human-computer interface, front-end user requirements analysis, modeling and validation, and 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 56 credits, 20 of which are from the required core. CIE is available for up to six credits. Hence, the CIE option requires students to take six credits more than the non- CIE option. Please see the IST

course listings for a full description of each course.

Required courses		Credits
INFO 608	**Human-Computer Interaction**	4.0
INFO 630	**Evaluation of Information Systems**	4.0
INFO 636	**Software Engineering Process I**	4.0
INFO 637	**Software Engineering Process II**	4.0

Distribution courses		Credits
INFO 503	**Introduction to Information Systems Analysis**	4.0
INFO 605	**Database Management I**	4.0
INFO 614	**Distributed Computing and Networking**	4.0
INFO 620	**Information Systems Analysis and Design**	4.0
INFO 646	**Information Systems Management**	4.0

Elective courses		Credits
INFO 603	**Application Programming for Information Systems**	4.0
INFO 606	**Database Management II**	4.0
INFO 607	**Applied Information and Database Technology**	4.0
INFO 616	**Computer-Supported Cooperative Work**	4.0

Computer Science Track

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

This track is designed for 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 a total of six track courses and a three-term project in addition to the 20 credits of required core courses. Of the six track courses, four courses must be from one of the six concentrations. The other two courses are electives. In addition to the six courses, students in the computer science track must participate in a three-term course project (equivalent to three courses). CIE is also available for up to 6 credits. Hence, the CIE option requires students to take 6 credits more than the non-CIE option.

Artificial intelligence concentration		Credits
CS 590	**Artificial Intelligence**	3.0
CS 770	**Topics in Artificial Intelligence**	3.0

CS 771	**Expert Systems**	3.0

Computing systems concentration		**Credits**
CS 720	**Operating Systems I**	3.0
CS 721	**Operating Systems II**	3.0
CS 740	**Computer Networks I**	3.0
CS 741	**Computer Networks II**	3.0

Database systems concentration		**Credits**
CS 750	**Database Theory I**	3.0
CS 751	**Database Theory II**	3.0
INFO 607	**Applied Information and Database Technology**	4.0
INFO 612	**Knowledge Base Systems**	4.0

Programming languages concentration		**Credits**
CS 559	**Formal Language Theory**	3.0
CS 560	**Programming Languages**	3.0
CS 761	**Compiler Construction I**	3.0
CS 762	**Compiler Construction II**	3.0

Scientific computation concentration		**Credits**
CS 680	**Special Topics: Computer Algebra I**	3.0
CS 680	**Special Topics: Computer Algebra II**	3.0
MATH 520	**Numerical Analysis I**	3.0
MATH 521	**Numerical Analysis II**	3.0

User interface software concentration		**Credits**
CS 585	**Computer Graphics I**	3.0
CS 586	**Computer Graphics II**	3.0
CS 680	**Special Topics: Graphical User Interfaces**	3.0
PSY 612	**Psychology of Human-Computer Interface Design**	3.0

Engineering Track

Track Coordinator: Dr. P. M. Shankar, 215-895-6632, shankar@ 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 25 or more credits of track courses in addition to the 20 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 M.S.S.E., including the 20 credits of core courses. Students opting for the CIE option are required to complete 48 approved credits, including 6 CIE credits.

Courses		**Credits**
ECEC 511	**Computer Hardware I**	3.0

ECEC 512	**Computer Hardware II**	3.0
ECEC 513	**Computer Hardware III**	3.0

Chemical engineering concentration		**Credits**
CHE 554	**Process Systems Engineering**	3.0
CHE 658	**Advanced Process Design**	3.0

Civil and architectural engineering concentration		**Credits**
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		**Credits**
ECEC 611	**Testing Computer Hardware I**	3.0
ECEC 612	**Testing Computer Hardware II**	3.0
ECEC 613	**Fault-Tolerant Computing**	3.0
ECEC 621	**Applied Computer Architecture I**	3.0
ECEC 622	**Applied Computer Architecture II**	3.0
ECEC 623	**Applied Computer Architecture III**	3.0
ECEC 624	**Computer-Aided Design and Graphics I**	3.0
ECEC 625	**Computer-Aided Design and Graphics II**	3.0
ECEC 626	**Computer-Aided Design and Graphics III**	3.0

NOTE: Any other ECE 600-level or above course may be eligible for credit.

Materials engineering concentration		**Credits**
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	**Credits**

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 676	**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

Faculty Research Interests
College of Arts and Sciences

Bruce W. Char, Ph.D. *(University of California at Berkeley), Professor*
Symbolic mathematical computation; algorithms and systems for computer algebra, problem-solving environments, and parallel and distributed computation.

Lloyd G. Greenwald, Ph.D. *(Brown University), Assistant Professor*
Artificial intelligence, planning, resource-bounded reasoning, anytime algorithms, robotics, sequential decision-making, real-time scheduling.

Nira Herrmann, Ph.D. *(Stanford University), Associate Professor*
Databases, expert systems, statistics.

Thomas T. Hewett, Ph.D. *(University of Illinois), Professor*
Human-computer interaction, cognitive psychology, computer applications.

R. Andrew Hicks, Ph.D. *(University of Pennsylvania), Assistant Professor*
Robotics, computer vision, catadioptics.

Jeremy R. Johnson, Ph.D. *(Ohio State University), Associate Professor*
Computer algebra, parallel computation, algebraic algorithms, scientific computing.

Werner Krandick, Ph.D. *(Ohio State University), Assistant Professor*
Computer algebra, parallel computation, computer arithmetic.

Spiros Mancoridis, Ph.D. *(University of Toronto), Assistant Professor*
Software architecture, reverse engineering, module interconnection formalisms, software visualization, software engineering education.

Jeffrey L. Popyack, Ph.D. *(University of Virginia), Associate Professor*
Operations research, stochastic optimization, computational methods for Markov decision processes, artificial intelligence, computer science education.

William C. Regli, Ph.D. *(University of Maryland at College Park), Assistant Professor*
Artificial intelligence, computer-aided design and manufacturing, Internet computing.

Ali Shokoufandeh, Ph.D. *(Rutgers University), Assistant Professor*
Theory of algorithms, graph theory, combinatorial optimization, computer vision.

Justin Smith, Ph.D. *(Courant Institute, New York University), Professor*
Parallel algorithms, artificial intelligence, computer vision.

Chunguang Sun, Ph.D. *(Pennsylvania State University), Assistant Professor*
Parallel and distributed computing, scientific computation, sparse matrix algorithms, programming languages.

College of Engineering

Nihat M. Bilgutay, Ph.D. *(Purdue University), Professor and Department Head of Electrical and Computer Engineering*
Systems; biomedicine: communication theory, ultrasonic imaging, nondestructive testing, signal processing.

Allon Guez, Ph.D. *(University of Florida), Professor*
Linear systems, nonlinear systems, robotics, optimal control.

Constantine Katsinis, Ph.D. *(University of Rhode Island), Associate Professor*
Computer architecture, modeling, and applications; parallel processing systems; fault-tolerant systems; operating systems; image processing and pattern recognition.

Alexander M. Meystel, Ph.D. *(ENIMS, Moscow, Russia), Professor*
Intelligent control, machine intelligence, autonomous systems, robotics.

Prawat Nagvajara, Ph.D. *(Boston University), Associate Professor*
Design and testing of computer hardware, fault-tolerant computing, error-correcting code.

Stewart D. Personick, Ph.D. *(Massachusetts Institute of Technology), E. Warren Colehower Chair Professor*
Systems, telecommunications, information networking, optical fiber systems.

Harish Sethu, Ph.D. *(Lehigh University), Assistant Professor*
Computers, computer architecture, switching networks and topologies, parallel and distributed computing, logic devices, computer arithmetic.

P. M. Shankar, Ph.D. *(Indian Institute of Technology, Delhi), Professor*
Telecommunications, mobile systems.

Lazar Trachtenberg, Sc.D. *(Technion Israel Institute of Technology), Professor*
Design and testing of hardware (multilevel gauge arrays), fault-tolerant computing, design of reliable suboptimal digital fibers.

Oleh Tretiak, Sc.D. *(Massachusetts Institute of Technology), Professor*
Computers and image processing: microcomputer image processing workstations, computer tomography, pattern recognition, computer systems.

College of Information Science and Technology

Michael E. Atwood, Ph.D. *(University of Colorado), Professor and Associate Dean*
Human-computer interaction, computer-supported cooperative work, organizational memory, software engineering, software project management, software process improvement.

William Evanco, Ph.D. *(Cornell University), Associate Professor*
Software engineering and systems analysis, software and process measurement, software performance.

Lewis Hassell, Ph.D. *(Drexel University), Assistant Professor*
Computer-supported cooperative work (CSCW), systems analysis and design techniques, database management systems.

Gregory W. Hislop, Ph.D. *(Drexel University), Associate Professor and Associate Dean*
Software evaluation and characterization, software development processes, software engineering education and practice, application of information technology to education.

Scott Paul Robertson, Ph.D. *(Yale University), Associate Professor*
Digital libraries, collaborative systems, cognitive systems, cognitive science, natural language comprehension, educational applications of information technologies, knowledge management, knowledge sharing.

Il-Yeol Song, Ph.D. *(Louisiana State University), Professor*
Database modeling and design, design and performance optimization of data warehouses and OLAP, database support for e-commerce and Web-based systems, and object-oriented analysis and design with UML.

June M. Verner, Ph.D. *(Massey University, New Zealand), Professor*
Software project management, software measurement, software process improvement, software development tools and techniques.

Vassilios S. Verykios, Ph.D. *(Purdue University), Assistant Professor*
Data mining, knowledge discovery in databases, data quality, database security, high-performance computing, performance analysis and evaluation.

Susan Wiedenbeck, Ph.D. *(University of Pittsburgh), Professor*
Human-computer interaction, empirical studies of programmers, interface design and evaluation, computer-supported cooperative work.