

**VILLANOVA UNIVERSITY
CATALOG**

**COLLEGE OF ENGINEERING
GRADUATE PROGRAMS**

2009-2010

While this catalog was prepared on the basis of the best information available at the time of publication, all information, including statements of fees, course offerings, admissions, and graduation requirements, is subject to change without notice or obligation.

VILLANOVA UNIVERSITY

August 2009

An Equal Opportunity Educational Institution

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GENERAL INFORMATION

Villanova University is under the direction of the Order of St. Augustine, known as the Augustinians. The University offices are open Monday through Friday from 9 a.m. to 5 p.m. The Office of the Associate Dean for Graduate Studies and Research is located in Room 303, Center for Engineering Education and Research (CEER).

The University campus is situated in Villanova, Pennsylvania, on Lancaster Avenue (U.S. Route 30), six miles west of City Line, Philadelphia, Pennsylvania.

The postal address is 800 Lancaster Avenue, Villanova, Pennsylvania 19085-1681. The University telephone number is 610-519-4500; the College of Engineering telephone number is 610-519-4940; the fax number is 610-519-5859.

Prospective students may obtain additional information on the University website: www.vuengineering.com.

Villanova University is an affirmative action institution complying with the requirements of Executive Order 11246 as Amended by 11375; Title IX; and the Rehabilitation Act of 1973, Sections 503 and 504. Villanova is authorized under Federal law to enroll nonimmigrant alien students. Note: The pronoun "he" as used in this publication usually refers to both male and female students.

HISTORY OF THE UNIVERSITY

For over one hundred and sixty years, Villanova University has been under the direction of the Order of St. Augustine, better known as the Augustinians, one of the oldest religious teaching orders of the Catholic Church. The first American foundation within the present limits of the United States was established in 1796 at Old St. Augustine's Church in Philadelphia. Villanova University traces its lineage from this foundation and from St. Augustine Academy, which was opened in 1811.

In January of 1842, the Augustinians at St. Augustine's took possession of "Belle Air," the country estate of the Revolutionary officer and merchant, John Rudolph. In accordance with an Old Catholic custom, the new foundation was placed under the patronage of a saintly hero of the past, St. Thomas of Villanova, a distinguished Augustinian writer, educator, and Bishop of sixteenth-century Spain. The school soon became known as Villanova and gave its name to the surrounding area.

Classes were opened in the old mansion house at "Belle Air" during the fall of 1843. On March 10, 1848, the Governor of Pennsylvania, Francis R. Shunk, signed the Act of Legislature incorporating "The Augustinian College of Villanova in the State of Pennsylvania" and conferring on Villanova College the right to grant degrees in the Arts and Sciences.

The Liberal Arts College took its first step toward university status in 1905 with the establishment of what is now called the College of Engineering. The Science unit, inaugurated in 1915, is an integral part of the present College of Liberal Arts and Sciences. The College of Commerce and Finance was founded in 1922, the College of Nursing in 1953, and the School of Law in 1953. Graduate studies were first separately administered in 1931.

Villanova's development over the years into a complex institution of higher education received official sanction when on November 10, 1953, pursuant to an act of the Legislature of the Commonwealth State of Pennsylvania, its charter was amended to permit its being designated Villanova University.

HISTORY OF THE COLLEGE OF ENGINEERING

The first engineering students were enrolled at Villanova University in the fall term of 1905. Four years later the first Engineering Degrees were awarded: two in Civil, and one in Electrical Engineering. During the next ten years, programs in Chemical and Mechanical Engineering were added.

In the period from 1953 through 1960, graduate programs in Chemical, Civil, Electrical and Mechanical Engineering were instituted. In 1987 a graduate program in Computer Engineering was begun. An undergraduate program in Computer Engineering was established in 1993. In 2003, an interdisciplinary graduate program leading to a Doctor of Philosophy (Ph.D.) in Engineering degree was initiated. In 2005 the College of Engineering celebrated its 100th Anniversary.

GOALS OF THE ENGINEERING PROGRAM

The major goal of a Villanova engineering education is: "To provide students with the opportunity to develop a greater technical competence in the chosen area of study."

The engineering faculty strives to develop a professional attitude in students; namely, the desire to grow intellectually through the continual search for and use of knowledge, and the motivation to become active, articulate and socially aware citizens.

The College of Engineering is committed to its responsibility to develop, collect and disseminate new knowledge in the engineering field and related areas.

ADMINISTRATION

OFFICERS OF ADMINISTRATION

President	PETER M. DONOHUE, O.S.A., Ph.D.
Vice President for Academic Affairs	JOHN R. JOHANNES, Ph.D.
Vice President and General Counsel	DOROTHY A. MALLOY, J.D.
Vice President for Administration and Finance	KENNETH G. VALOSKY
Vice President for Student Life	JOHN P. STACK, O.S.A.
Vice President for Institutional Advancement	MICHAEL J. O'NEILL
Vice President for University Communication	ANN E. DIEBOLD

ENGINEERING ADMINISTRATION

Dean	GARY A. GABRIELE, Ph.D. 310 CEER 610-519-4940
Associate Dean, Academic Affairs	GERARD JONES, Ph.D. 301 CEER 610-519-4985
Associate Dean, Graduate Studies and Research	ALFONSO ORTEGA, Ph.D. 303 CEER 610-519-7440
Associate Dean, Students and Strategic Planning	STEPHEN JONES, Ph.D. 203 CEER 610-519-5439
Chairs:	
Chemical Engineering	RANDY D. WEINSTEIN, Ph.D. 215 White Hall, 610-519-4950
Civil and Environmental Engineering	RONALD A. CHADDERTON, Ph.D. 139 Tolentine Hall, 610-519-4960
Electrical and Computer Engineering	PRITPAL SINGH, Ph.D. 411B Tolentine Hall, 610-519-4971
Mechanical Engineering	C. NATARAJ, Ph.D. 131 Tolentine Hall, 610-519-4980

FACILITIES

COMPUTERS

College and University Computing

The entire campus is linked via a high-speed network and is connected to the internet. The College has multiple computer labs reserved for use exclusively by engineering students. Access to the workstations in these labs is provided 24 hours a day, 7 days a week, with proper authorization of the student's Wildcard. The College also provides several remote access solutions, such as Terminal Services for remote application execution, and Virtual Private Networks, for campus equivalent network connectivity.

Departmental Computing

The **Chemical Engineering** Department makes available a number of personal computers for student use in carrying out classroom assignments. It has also dedicated several personal computers to data acquisition and control in laboratory experiments. Chemical Engineering students run large-scale packaged software for design of process systems, primarily Aspen's ASPEN PLUS. The departmental computer laboratory also provides a wide range of special-purpose software prepared by the ChE department faculty in the sciences of material and energy balances, thermodynamics, process control, fluid flow, and heat/mass transfer.

The **Civil and Environmental Engineering** Department's computer facilities include personal computers and associated printers and plotters. A variety of commercial and in-house developed software including MATHCAD, MATLAB, ANSYS, STAAD-PRO, CONSPAN, HEC-RAS, HEC-HMS, HCS, KERN, KYPIPES, HY8, and AUTOCAD, are used in the curriculum. Student exposure to computer-based applications includes spreadsheet and economic analysis, structural design of buildings and bridges, simulation of operating piping-pumping systems, sensitivity and matrix analysis of civil engineering systems, generation of hydrographs, culvert hydraulics, and transportation system planning.

The **Electrical and Computer Engineering** Department utilizes Sun servers and workstations, which are available in the Advanced Computer System Laboratory and Communications Research Laboratory. In addition, the department has PCs and Motorola 68000 microprocessor systems. The department software includes Matlab, Simulink, HP Design Center, Cadence PSpice and Mervov Graphics IC design tools. This software is used for digital signal processing, microwave system design, and the design of analog and digital circuits and systems.

The **Mechanical Engineering** Department has personal computers that are equipped with data acquisition systems and software for graphing, designing, and calculating. Software includes MATLAB, FLUENT, MATHCAD, ANSYS, AUTOCAD, ALGOR, PCDEFORM, DADS, Working Model 3D, SolidWorks, ABAQUS, and other applications programs used for finite element analysis, heat transfer and fluid flow, and multi-body dynamic analysis.

LABORATORIES

Dedication of the Center for Engineering Education and Research (CEER) took place in June 1998. The multi-million dollar facility provides leading edge technological support for teaching and research in the College of Engineering.

The 88,400 square-foot structure houses instructional and research laboratories, a computer-aided engineering center, an interdisciplinary student projects laboratory, student group study rooms, and a multi-media lecture hall seating 140.

The **Chemical Engineering** Department maintains modern laboratory facilities to support both undergraduate and graduate educational programs, as well as research. Experimental capabilities range from demonstration of fundamental principles in bench-scale or pilot-scale equipment to hands-on experience with fully integrated, industrial scale process equipment. Dedicated research laboratories support several ongoing faculty research programs. In addition, the department maintains extensive general purpose laboratory capabilities for those students who carry out independent investigations as part of their program of studies.

The **Civil and Environmental Engineering** Department is committed to "hands-on" education in its experimental, computational, and design laboratories. Facilities are currently dedicated to instruction and research capabilities in environmental engineering, fluid mechanics and hydrology, geotechnical engineering, geology, structural engineering and water resources.

The **Electrical and Computer Engineering** Department laboratory facilities are available to serve as important components of study in specialized areas as well as for core studies. Laboratories are currently in place for instruction and research in Control Systems, Digital Systems and Microprocessors, Electronics, Signal Processing, Communication Systems, Solid State Devices, Microwaves, Microcontrollers, Antenna Anechoic Chamber, Antenna Research, Communications, and Student Projects.

The **Mechanical Engineering** Department laboratories provide an environment for students to reinforce their understanding of the fundamental principles of mechanical engineering and apply that knowledge in experimental analysis and problem-solving. Laboratories currently available include Manufacturing Processes, Thermodynamics, Engine Testing, Materials Testing and Material Science, Vibration, Stress, Heat Transfer, and Wind Tunnel.

FACULTY

Practical experience in governmental agencies, large and small industrial and manufacturing settings, and various consulting engineering fields is characteristic of the faculty of the Engineering College. Diversity is enhanced by the presence of a number of professors who come from other countries. All members of the faculty share a commitment to effective teaching and research and to preserving the supportive personal atmosphere which prevails in the College. A philosophy of easy access to faculty is facilitated by maintaining an advisement policy and availability for consultation.

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OTHER GRADUATE PROGRAMS

In addition to the graduate programs in the College of Engineering, Villanova University has graduate programs in the School of Business, College of Arts and Sciences, and College of Nursing. Detailed descriptions of these graduate programs can be found in the current Graduate School Bulletins of each of these Colleges. Copies of them are available online and in the offices of the College Deans:

<i>School of Business</i> Graduate Business Program Bartley Hall 1074 610-519-4336	<i>College of Arts and Science</i> Graduate School, Kennedy Hall, 2 nd Floor 610-519-7090	<i>College of Nursing</i> Graduate Program Driscoll Hall 610-519-4934
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NON-ENGINEERING COURSES

Graduate course descriptions from the departments of Biology, Chemistry, Computer Science, and Mathematical Sciences are provided in the Graduate Catalog of the College of Arts and Sciences. It should be noted that graduate physics course choices can be provided on an individual basis, with special permission. To pursue these options, contact the Physics Chairperson.

POLICIES AND PROCEDURES

COURSE NUMBERING

Courses designated 7000 to 7999 are graduate courses to which qualified undergraduate students are admitted for undergraduate credit with the permission of the Department Chairperson. Courses designated 8000 to 9999 are normally intended for graduate students only.

DISCLOSURE OF STUDENT RECORDS

Villanova University, in accordance with the Family Educational Rights and Privacy Act (FERPA) of 1974, as amended, has adopted this Student Records Policy to address the following issues: (1) disclosure of directory information; (2) confidentiality of personally identifiable information; and (3) student rights to inspect, review and seek amendment of their records.

I. Disclosure of Directory Information. Information concerning the following items about individual students is designated by the University as directory information and may be released or published without the student's consent: full name; address (local, home or electronic mail); telephone number; photograph; date and place of birth; major field of study; dates of attendance; degrees and awards received; most recent previous educational institution attended; participation in officially recognized University activities and athletics; and weight and height of members of athletic teams. Students who do not wish directory information to be released or made public must inform the appropriate office in writing, at the time the information is originally sought.

II. Confidentiality of Personally Identifiable Information. All personally identifiable information contained in student records other than directory information is considered confidential information. This information includes, but is not necessarily limited to: academic evaluations; general counseling and advising records; disciplinary records; financial aid records; letters of recommendation; medical or health records; clinical counseling and psychiatric records; transcripts,

test scores, and other academic records; and cooperative work records. “Personally identifiable information” means that the information includes: (a) the name of the student; (b) the address of the student; (c) a personal identifier such as social security number; or (d) a list of personal characteristics or other information that would make the student’s identity easily traceable.

The University will generally not disclose personally identifiable information to third parties without the written consent of the student. The consent should specify the records to be disclosed, the purpose of the disclosure, and to whom the records are to be disclosed. However, personally identifiable information may be disclosed, without the student’s consent, to the following individuals or institutions, or in the following circumstances:

- University officials (or office personnel ancillary to the officials) who require access for legitimate educational purposes such as academic, disciplinary, health or safety matters. University officials may include, without limitation, the President, Vice Presidents, Deans, Directors, Department Chairs, Faculty Members, NROTC Commanding Officer, General Counsel, Deputy General Counsel, Judicial Officers, Counselors, Resident Advisers, Coaches and Admission Officers.
- Officials of other educational institutions to which the student seeks or intends to enroll (on condition that the student upon request is entitled to a copy of such records).
- Appropriate federal, state or local officials or authorities, consistent with federal regulations.
- Organizations conducting studies for, or on behalf of, educational agencies or institutions.
- Accrediting organizations to carry out their accrediting functions.
- Parents or guardians of a student, where the information pertains to violations of any federal, state or local law or of any University rule or policy governing the use or possession of alcohol or a controlled substance, and the student has committed a disciplinary violation.
- In connection with the student’s application for, or receipt of financial aid.
- To comply with a judicial order or lawfully issued subpoena (on condition that a reasonable effort is made to notify the student of the order or subpoena, if legally permitted to do so).
- In case of an emergency, to protect the health or safety of students or other individuals.

The University will inform a party to whom a disclosure of personally identifiable information is made that it is made only on the condition that such party will not disclose the information to any other party without the prior written consent of the student.

III. Inspection and Review Rights; Right to a Hearing. A currently or previously enrolled student has the right to inspect and review his or her educational records. This right does not extend to applicants, those denied admission, or those admitted who do not enroll. Offices may require that requests for access be submitted in writing, and may ask for, but not require, the reason for the request. The University will comply with requests to inspect and review a student’s records that it has determined to honor within a reasonable period of time, but in no case more than forty-five days after the request was made.

Records to which students are not entitled to access include:

- Confidential letters and statements or recommendation placed in a student’s record before January 1, 1975, or confidential letters and statements of recommendation to which students have waived their right of access.
- Employment records of students as University employees.
- Campus law enforcement records created and maintained by the Public Safety Office, in accordance with the requirements of FERPA.
- Records that are made or maintained by a physician, psychiatrist, psychologist, or other recognized professional or paraprofessional acting in his or her professional capacity or assisting in his or her paraprofessional capacity, and that are made, maintained, or used only in connection with treatment of the student and are not disclosed to anyone other than the

individuals providing the treatment. These records may be reviewed, however, by a physician or other appropriate professional of the student's choice.

- Financial records of the parents of the student or any information contained in those records.
- Records of instructional, supervisory, and administrative personnel and educational personal ancillary to those persons that are in the sole possession of the maker of the record and are not accessible or revealed to any other individual except a temporary substitute for the maker.
- Institutional records of students which may be maintained by the University in a computer printout or similar format (so long as this computerized information is not intended to be distributed outside the University), as long as the original source of computer information is available in the office or department having original jurisdiction for the records.
- Records that only contain information about a person after that person was no longer a student at the University (e.g., information collected by the University pertaining to accomplishments of its alumni).
- Those portions of a student's records that contain information on other students.

Students may be invited but not required to waive their right of access to confidential letters of recommendation for admission, honors or awards, or employment. Failure to execute a waiver will not affect a student's admission, receipt of financial aid, or other University services. If a student signs a waiver, he/she may request a list of all persons making confidential recommendations.

A student who believes that any information contained in his or her educational records is inaccurate or misleading, or otherwise in violation of his or her privacy rights, may request that the University amend the records. The student should first discuss his or her concerns with the individual responsible for the office where the records are maintained. If the student is not satisfied with the resolution, the student should contact the individual to whom that person reports. If still not satisfied, the student may contact the appropriate vice president or designee. The final level of appeal is a formal hearing. To obtain a hearing, the student should file a written request with the Vice President for Student Life. The hearing will be conducted in accordance with the requirements of FERPA.

The substantive judgment of a faculty member about a student's work (grades or other evaluations of work assigned) is not within the scope of FERPA hearing. A student may challenge the factual and objective elements of the content of student records, but not the qualitative and subjective elements of grading.

If as a result of a hearing the University determines that a student's challenge is without merit, the student will have the right, and will be so informed, to place in his or her records a statement setting forth any reasons for disagreeing with the University's decision.

Students have a right to file complaints concerning alleged failures by the University to comply with the requirements of FERPA and the implementing regulations. Complaints should be addressed to the Family Policy Compliance Office, U.S. Department of Education, 400 Maryland Avenue, S.W., Washington DC 20202-4605. Students are encouraged to bring any complaints regarding the implementation of this policy to the attention of the General Counsel.

GRADUATE GRADING SYSTEM

Grades are recorded at the end of each semester or summer session. The student receives his grades on the University NOVASIS website. Any inaccuracy must be reported by mail to the Registrar immediately.

The work of the student is graded according to the following scale:

A	Outstanding	C	Fair
A -		F	Failure
B +		WX	Approved Withdrawal
B	Good	NF	Incomplete
B -		AU	Audit
C +		IP	In Progress

Students are not required to repeat courses in which the grade of F has been received, unless the courses are specifically required by the program in which they are enrolled, the decision resting with the chairperson of their major department.

An N (incomplete) grade indicates the instructor is not prepared to give a definite grade for the course in view of the student not having completed all the assigned work. The NF grade automatically becomes an F if the work is not completed and submitted to the instructor. For the fall semester, students must submit all work by the last Friday in January. For the spring semester, all work must be submitted by the last Friday in June. Faculty members, in turn, submit grade changes within two weeks of these dates to the Registrar. Change of grades to C+ or higher cannot be made without the approval of the professor, the department head, and the Associate Dean for Graduate Studies and Research in the College of Engineering.

Grades are part of the student's permanent record. Grade changes other than conversion of N grades can be made only with special permission from the Associate Dean for Graduate Studies and Research in the College of Engineering.

In graduate study, the student is expected to do more than pass the required courses. In addition, students must maintain a specific average. This average, known as the grade point average, derived from the grades and credit hours of the courses taken, is computed by multiplying the number of credits for each course the student has attempted by the authorized quality points for the grades received and dividing the total quality points by the total credit hours attempted. The grade A merits 4 quality points; A- = 3.67; B+ = 3.33; B = 3; B- = 2.67; C+ = 2.33; C = 2; F = 0; NF = 0.

The student is required to maintain a grade point average of at least 3.00 and cannot be approved for the comprehensive examination or graduation unless this average has been maintained.

GRADUATE STATUS

- Full-Time - A full-time graduate student is enrolled in 9 or more credits per spring or fall semester. Students working as teaching or research assistants are considered to be full-time when enrolled in 6 or more credits per spring or fall semester.
- Part-Time - A part-time graduate student is enrolled in less than 9 credits per given fall or spring semester.
- Inactive - A graduate student is deemed inactive if he has not enrolled in an approved graduate course within the last four fall and spring semesters (summers not counted).

GRADUATION

Students who expect to be graduated have the responsibility of [applying](#) for graduation to their department office at the beginning of the semester in which they will complete their degree program. The deadline for Graduation Application is listed in the College of Engineering [calendar](#) for each semester.

LANGUAGE REQUIREMENTS

There is no language requirement in any of the graduate programs of the College of Engineering. However, foreign students are required to submit their scores on the Test of English as a Foreign Language (TOEFL) in their application for admission.

LENGTH OF DEGREE PROGRAMS

Normally all graduate degree requirements must be completed within a seven-year time period. This time period is counted from the student's first registration to the date of completing the degree at Villanova University. Courses are dropped after seven years.

PROBATION

A student whose GPA falls below the required minimum of 3.0 is placed on probation. A student on probation who fails to improve his academic performance may be withdrawn from the program by the Associate Dean for Graduate Studies and Research in the College of Engineering upon recommendation by the department chairperson.

QUANTITATIVE DEGREE REQUIREMENTS

Candidates for the Master's degree must complete the courses prescribed by the chairperson of their department. Thirty semester hours credit with a quality point average of at least 3.00 is required for the degree. Candidates for the Doctor of Philosophy in Engineering degree must follow the program of study which is drawn up by the student's Research Advisor.

REGISTRATION

Students who have been admitted to graduate studies register at the time announced in the academic calendar with the advice of the chairperson of their department, or his/her representative, whose approval is necessary for all the courses students wish to take.

If students desire to audit courses and not receive credit, they are required to file an application, with the application fee, and furnish the same records as students who are applying for degree credit. The student who has been granted audit status will not be responsible for the assignments and examinations required in the course. Although no credit or grade is received, the same tuition and fees are charged for the audit as for credit courses. The regulations applicable to changes in registration status (drops and adds) also apply to audit students.

Graduate courses are offered in the fall and spring semesters and in the summer sessions on a

full- and part-time basis. During the fall and spring semesters a student (except for graduate assistants, who are considered full-time students) registered for fewer than nine credits is classified as a part-time student.

THESIS

In those cases where a thesis is required or elected, the student is expected to do as a minimum the equivalent of six semester hours of work. Usually the thesis is prepared under the supervision of a faculty member of the major department who is prepared to undertake the supervision of the student's research. Students will need to have frequent conferences with their thesis advisor and, therefore, should not expect to receive supervision by mail. Research may be initiated by the student at a time approved by the department, but not until after the thesis topic forms have been approved by the department. Some departments may require a scholarly report in lieu of or in addition to a thesis. Consult departments for details.

TRANSFER OF CREDITS

Transfer credits toward graduate engineering degrees will, in general, be granted for appropriate academic work completed with a grade of "B" or better (or equivalent) at an accredited university. A maximum of six graduate credits may be transferred toward graduate degree requirements and normally these credits must have been earned within the seven-year period in which a student is expected to complete the degree and as long as the courses have not been counted as part of an undergraduate degree.

Transfer credits are not included in the calculation of the grade point average.

WITHDRAWAL FROM A COURSE

Engineering student requests for authorized withdrawal from a course will be automatically approved by the Associate Dean for Graduate Studies and Research in the College of Engineering until the date given in the academic calendar. After that date the student must present a valid reason for the request, such as insufficient information to determine standing in the course, i.e., grades on tests and assignments, also serious personal or medical problems. The Associate Dean for Graduate Studies and Research in the College of Engineering will decide whether or not to grant these requests based on the information supplied by the student and recommendations from the faculty member teaching the course and the chairperson of the department in which the student is majoring. The Associate Dean for Graduate Studies and Research in the College of Engineering will inform the student of his decision and the reason for it.

WITHDRAWAL FROM THE PROGRAM

Graduate students in engineering who withdraw voluntarily from the program for any reason should notify the Associate Dean for Graduate Studies and Research in the College of Engineering of this fact in writing.

Graduate students who are withdrawn and wish to resume their studies in engineering must request approval for their readmission to the program in writing from the Associate Dean for Graduate Studies and Research in the College of Engineering.

STUDENT SERVICES

CAREER SERVICES (www.careers.villanova.edu)

Employment services include: an on-campus interview program, resume referrals, and job listings. These services are managed through the office website at www.careers.villanova.edu.

Career planning services include individual career counseling and assistance with resume writing and interviewing. A career library houses career and employer information. The office is located in Corr Hall. Hours are Monday-Friday, 9 a.m.-5 p.m., with additional hours during the academic year. Phone number is 610-519-4060.

COUNSELING CENTER (www.studentlife.villanova.edu/counselingcenter)

The University Counseling Center, located in Health Services Building Room 206, offers a number of services. Except for emergencies, appointments are required and can be scheduled either by phone (610-519-4050) or by visiting the Center.

Personal/Psychological Counseling

The Counseling Center helps students deal with personal concerns and decisions by providing a private and confidential setting in which to discuss the emotional impact of events that commonly occur during a student's normal developmental process. Counseling is provided on a voluntary basis. All contacts are completely confidential. Information is not released to anyone without the student's permission. The following services are available:

- Individual counseling to discuss areas of student concern, to provide emotional support during stressful periods, to help identify and change defeating habits and attitudes, and to increase awareness of alternative, productive behavior.
- Alcohol and Drug assistance: helps students address destructive patterns of drug or alcohol misuse.
- Consultation with organizations, departments, clubs, faculty, and administrators to promote optimal functioning. Individuals may consult a psychologist about how to help a friend or family member who seems to need help.
- Group formation and programs on themes that interest students. Examples are: eating awareness; coping with the death of a loved one; interpersonal relationships; and time management.

Study Skills Counseling

Counselors are available to help students enhance their study skills and optimize their motivation and success in studying. Students receive help with time management, note taking, effective test-preparation and test-taking, and other skills related to academic performance. Individual appointments are available, as are group workshops, a schedule for which can be obtained by stopping by the Center. No advanced registration is required for workshops.

Hours by appointment, Mon.-Fri.: 9 a.m. to 5 p.m., Phone: 610-519-4050

FINANCIAL ASSISTANCE (www.finaid.villanova.edu)

Graduate students who are accepted and matriculated into a degree program and are enrolled on at least a half-time basis each semester can apply for a Federal Stafford Student Loan to help meet the cost of education. (Half-time status is defined by your academic program of study. Typically, graduate students need to be enrolled in at least 6 credits per term to be considered half-time.)

HEALTH CENTER (www.villanova.edu/studentlife/healthcenter)

The Villanova Student Health Center (610-519-4070) is staffed by registered nurses 24 hours daily during the school year to meet the needs of all Villanova students. Physicians and Nurse Practitioners are available weekdays by appointment. Gynecologic services are provided by the Nurse Practitioners by appointment. Registered nurses provide 24 hour care to students who require inpatient treatment and observation. Other medical services include diagnostic laboratory testing, administration of allergy injections and immunizations. In the event that a student requires emergency care, transportation is provided to a local hospital. Though students are not billed for physician or nurse practitioner visits, they are financially responsible for prescription medications and laboratory fees, as well as consultation with specialists.

HOUSING (www.reslife.villanova.edu)

Currently, residence hall bed space is devoted exclusively to undergraduate students. The Office for Residence Life does, however, maintain an extensive list of off-campus opportunities, some of which are designated specifically for graduate students. To review this list, go to the Residence Life web page - <http://reslife.villanova.edu/> and click on Off-Campus Housing.

INTERNATIONAL STUDENT OFFICE (www.students.villanova.edu/iss)

The International Student Office is a service provided by the University to aid international students in becoming oriented to the University and the community. An orientation program for international students is held at the beginning of every semester. The international student may also use the ISO for aid with U.S. immigration requirements, off-campus employment permission, social security, tax referral information, and other resources in the community/University.

The Office sponsors a variety of programs such as Immigration Workshops by area lawyers, Multi-Cultural Dinner Night, Chinese New Year, and Passages: The International Journal, for the purpose of promoting and strengthening cross-cultural understanding. Through participation in the International Student Activities and Cultural Clubs on-campus, the student has the opportunity to supplement his classroom education by sharing in the customs and culture of others.

All international students must register with the International Student Advisor each semester upon arrival. Any change of address must be reported immediately.

LIBRARY (www.library.villanova.edu)

The Falvey Memorial Library provides resources and facilities for study and research by graduate and undergraduate students, faculty and visiting scholars.

The library is fully automated and provides access to a wide variety of electronic information

as well as to traditional print sources. In addition to more than 817,000 volumes, approximately 3,000 periodical subscriptions, and over one million pieces of microforms, the library offers access to several hundred local and remote databases, including Lexis/Nexis, Dow Jones, and the Internet through FLASH, Falvey Library Academic Search (<http://www.vill.edu/library>). Falvey shares in a selective depository status for federal government documents with Pulling Law Library. Reference services are usually available when the library is open.

THE UNIVERSITY SHOP (www.ushop.villanova.edu)

Villanova University operates a bookstore where students may purchase texts and general supplies. See www.ushop.villanova.edu or call 610-519-4160 for current hours.

TUITION AND FEES¹

Application Fee (non-returnable)	\$50
Tuition	\$910/credit
General University Fee's	\$30/semester
Thesis Binding	\$15 per copy

Please see the Bursar's webpage for a complete listing of Tuition and Fees.

If you are enrolled in or are taking courses in another college/division, please check the appropriate catalog for rates.

Registration or the release of academic records cannot be completed until all financial obligations have been settled with the Bursar's Office.

PAYMENT OF TUITION

Tuition payment is due no later than the first day of class. This requirement applies to all students, including those who register too late to receive a bill. Students must pay their accounts by the first day of class or they are subject to a late payment fee. Please click [here](#) for payment methods.

REFUND OF TUITION

Graduate students who obtain approval for withdrawal from a course or the program are entitled to a tuition refund in accordance with the following policy.

Approved Withdrawal Prior to the End of:	Percent of Tuition Refunded:
First full week	80%
Second full week	60%
Third full week	40%
Fourth full week	20%

After the end of the fourth full week of the semester there will be no tuition refund for approved withdrawals.

GRADUATE DEGREE PROGRAMS IN ENGINEERING

DOCTOR OF PHILOSOPHY IN ENGINEERING

In 2003, the College of Engineering initiated a new graduate program leading to a Doctor of Philosophy (Ph.D.). The primary purpose is to provide scholars for industry and academe, emphasizing the attributes of excellence, innovation and integrity. The course of study is integral to the strategic plan of the College, congruent with the mission of the Villanova University, reflective of the future of the engineering profession, and consonant with the emerging trends in 21st century academe.

OBJECTIVES

The doctoral program is designed to prepare scholars, teachers, and leaders for academia and industry in contemporary and emerging engineering fields. Its primary component is independent, directed research leading towards a dissertation. The Ph.D. degree can be achieved with a concentration in any of the engineering programs offered in the College of Engineering. The program is designed to encourage intellectual depth within the area or discipline of study while also providing enough flexibility to allow for breadth across disciplinary lines when useful for multi-disciplinary research topics. The Villanova University Engineering Ph.D. program is one of the few programs in the country that will allow the degree to be pursued on a part-time basis by working professionals, with many of the relevant courses available through our state of the art on-line Distance Education program.

ADMISSION REQUIREMENTS

Applicants are required to hold a bachelor's degree in engineering from an ABET accredited institution or established foreign institution. Applicants who do not already have a master's degree will spend the first portion of the program taking courses normally part of the master's program, and may earn a master's degree during the course of their studies. Students will apply directly to the program, and applications will be directed to the Doctoral Program Coordinator.

In order to be considered for admission, an applicant must complete the online application form and submit it to the Office of University Admissions. This form includes the following requirements:

- 1) Official transcripts of all previous college work (both undergraduate and graduate where applicable) signed and sealed in the envelopes provided. This must include the student's rank in class and grade point average.
- 2) Official score report for the Graduate Record Examination (GRE).
- 3) Two completed recommendation forms, with supporting letter attached, from persons well-acquainted with the applicant's work. If currently employed, a letter from the applicant's employer will be accepted as one letter of recommendation. The envelopes must be signed and sealed by the evaluator.
- 4) Evidence of oral and written communication skills as evidenced through interview, recommendations, and written statement of research interests and career goals.
- 5) International students whose native language is not English, an official score report for the Test of English as a Foreign Language (TOEFL) examination of at least 600 (written test) or 250 (computer-based test).

- 6) Application fee of \$50 (non-refundable) payable in U.S. funds when application is submitted. Check or money order should be made payable to Villanova University.

DEGREE REQUIREMENTS

Following admission into the doctoral program, a Guidance Committee is appointed for the student by the Program Coordinator upon recommendation of the Doctoral Advisory Committee and the student's faculty advisor. This committee assists the student in outlining his program and may specify individual coursework requirements. The Villanova College of Engineering Doctoral Program is committed to academic excellence. As a part of this continuing commitment, it is required that doctoral candidates produce peer review of their work, in the form of timely publications at relevant conferences and/or archival journals, and include them in their dossier at the time of dissertation defense.

Detailed program requirements for students with MS degree

- The student must take a minimum of six courses (18 credits) including at least one graduate level mathematics course. The actual courses and any additional courses will be listed in a program of study that will be drawn up by the student's Guidance Committee.
- The student will be required to register for 30 credits of research.
- The student will be required to take a qualifying examinations preferably before the end of the second semester or as determined appropriate by his/her Guidance Committee. This examination will be in two areas: mathematics and a discipline specific exam. A maximum of two attempts is permitted to pass this examination.
- In addition, he/she is required to defend a proposal of dissertation as well as a final dissertation defense

Detailed program requirements for students with BS degree entering directly into the Engineering Doctoral Program

This path is highly selective and limited to only the most highly qualified candidates.

- The student must take a minimum of fourteen courses (42 credits) including at least one graduate level mathematics course. The actual courses and any additional courses will be listed in a program of study that will be drawn up by the student's Guidance Committee.
- The student will be required to register for 30 credits of research.
- The student will be required to take the qualifying examinations before the end of the fourth semester or as determined appropriate by his Guidance Committee. This examination will be in two areas: mathematics and a discipline specific exam. A maximum of two attempts is permitted to pass this examination.
- In addition, he/she is required to defend a proposal of dissertation as well as a final dissertation defense.
- The degree requirements must be completed within six years following the passing of the qualifying examination.

Detailed program requirements for part-time students

They have the same requirements as the full-time students.

MASTER OF SCIENCE PROGRAM

The College of Engineering currently has master's degree programs offered by the following departments: Chemical, Civil and Environmental, Electrical and Computer, and Mechanical Engineering. In addition to the traditional master's degree designations in each of these four engineering disciplines, the Civil and Environmental, and the Electrical and Computer Engineering Departments provide the opportunity to pursue a graduate degree in more highly specified areas within their respective fields, i.e., Water Resources and Environmental Engineering and Computer Engineering. Also available are concentrations within each of the disciplines.

Students who successfully complete any of the following degree programs receive a Master's degree.

Master of Science in Chemical Engineering
Master of Science in Civil Engineering
Master of Science in Water Resources and Environmental Engineering
Master of Science in Computer Engineering
Master of Science in Electrical Engineering
Master of Science in Mechanical Engineering
Master of Science in Sustainable Engineering

Classes are held in the late afternoon and evening and are open to both part-time and full-time graduate students.

OBJECTIVES

The primary objectives of the engineering graduate programs are: (1) to educate full- and part-time students in order to enhance their technical competence and continue their professional development, and (2) to prepare full- and part-time students for further graduate study at the doctoral level.

ADMISSION

Admission Requirements

All applicants to graduate programs in the College of Engineering at Villanova must possess a bachelor's degree. For those applicants who hold a degree from a U.S. college or university, the school must be a regionally or nationally accredited institution of higher education. In the case of applicants who hold a degree from a foreign institution, the Graduate Record Examination, GRE (General Test), is required. In some cases the Chemical Engineering Department may request the GRE (General Test) of an applicant who holds a degree from a US institution. In addition, if the native language of the applicant is not English, the Test of English as a Foreign Language (TOEFL) is required.

Prospective graduate students must apply for admission into a specific engineering graduate degree program in the College of Engineering. The normal credential for admission into a specific engineering graduate degree program is an undergraduate degree in the field of engineering that corresponds to the graduate degree awarded by that program (e.g., a Bachelor's Degree in Chemical Engineering is the normal credential for pursuing a Master's Degree in Chemical Engineering). This bachelor's degree should be from an undergraduate engineering program that is accredited by the

Accreditation Board of Engineering and Technology (ABET).

Prospective students may apply to any graduate program even though they hold a bachelor's degree in a different engineering discipline, a related scientific or technical field, a non-technical area, or an engineering degree from an undergraduate program not accredited by ABET (such as a non-U.S. institution). If admitted, such students will be required to take specified undergraduate courses in order to make up any deficiencies in their undergraduate preparation for graduate studies in that particular graduate program. The number and type of undergraduate courses specified will depend on the graduate degree sought and will be in addition to the graduate courses required for that degree.

The primary criteria used to evaluate the academic potential of the applicant for admission to graduate studies are:

- 1) The collegiate scholastic record in terms of the quality and consistency of performance and the difficulty of the curriculum;
- 2) The final undergraduate cumulative Grade Point Average (GPA), which should normally be a 3.0 or better;
- 3) Recommendation forms (with optional letters attached) from professors and, if appropriate, employers who know the candidate sufficiently well to assess academic potential;
- 4) Scores earned on standardized tests such as the GRE (General Test) or TOEFL, if required/submitted.

Admission to Individual Graduate Courses

Students who wish to take graduate courses for credit or audit without completing a certificate or degree program may apply for admission to those specific courses (a maximum of **two** such courses may be taken). The normal credential for admission to any such course will be an undergraduate degree, plus evidence that the background of the student includes sufficient preparation to predict success in the course selected.

The student must complete an online application form, Individual Course Application (ICA), for admission to graduate courses in the College of Engineering, and transmit this to the department of offering the course, along with their undergraduate transcript.

The educational background of the applicant will be evaluated by the department offering the course. If the student is deemed to be qualified, admission to the course(s) will be granted by the department.

Acceptance to individual course(s) does not imply acceptance to any other graduate program in the College of Engineering. If, after completing the course(s), the student wishes to apply to a degree or certificate program of the College, he must apply to that program in the normal manner. The individual courses taken may be counted towards the graduate degree.

Admission Procedure

Inquiries regarding application materials, catalogs, etc. are directed to the department that offers the degree program of interest.

A complete application for admission must contain the following materials:

- 1) A completed application form
- 2) Two recommendation forms, with optional letters attached
- 3) Transcripts of all undergraduate and graduate course work
- 4) \$50 application fee

- 5) In the case of non-U.S. citizens: Visa application information form, TOEFL score, GRE (General Test) scores, and required financial documentation

The completed application materials are submitted by the applicant prior to the following dates:

For Entrance in

Application Deadline

Fall semester	<ul style="list-style-type: none"> • for priority consideration for assistantship/scholarship • for foreign students from non-U.S. institutions • for foreign students from U.S. institutions • for U.S. citizens 	January 15 April 1 July 1 August 1
Spring semester	<ul style="list-style-type: none"> • for foreign students from non-U.S. institutions • for foreign students from U.S. institutions • for U.S. citizens 	October 1 November 1 December 1
Summer semester	<ul style="list-style-type: none"> • for foreign students from non-U.S. institutions • for foreign students from U.S. institutions • for U.S. citizens 	N/A April 1 May 1

After completed application packages are received, they are reviewed by the department that offers the degree program to which admission has been requested. The decision is communicated to the applicant in writing.

DISTANCE EDUCATION

The College of Engineering has three world-class distance education classrooms that have allowed it to be the first college at Villanova to offer Online Master's Degrees. With 5 graduate degrees online as of Fall 2006, the College of Engineering is leading the way in Distance Education worldwide.

Using Video Conferencing, Tablet PCs, and the latest rich-media web broadcast, classes can be delivered anytime, anywhere, to anyone.

Highlights of the program are:

- Same cost as regular in-class tuition
- National recognition as a premier provider of rich-media broadcasts
- Live interaction with live classes
- Same registration process as regular students.

For more information, FAQs, pictures, and sample content, visit http://www.villanova.edu/engineering/academics/distance_ed/

CERTIFICATE PROGRAMS

Certificate Programs are available to qualified working professionals who are interested in enhancing their knowledge in a specific area. The College of Engineering offers fourteen certificate programs.

Admission requirements are the same, unless specified, as those for the graduate degree programs. Students will be required to meet all the course prerequisites and maintain a Grade Point Average of at least 3.00. Courses completed for the Certificate could be applied toward a Master's degree should the student wish to continue.

BIOCHEMICAL ENGINEERING CERTIFICATE

A concentration in **Biochemical Engineering**, administered by the department of **Chemical Engineering**, is available to graduate students matriculating in the College of Engineering. A graduate student interested in the Biochemical Engineering Certificate should make application to a specific engineering department. Once accepted into the College of Engineering graduate program, the student should contact the Chemical Engineering Department regarding this Certificate.

The Certificate program in Biochemical Engineering is a concentration of courses that introduce the fundamentals of Biochemical Engineering, and topics supporting the Biotechnology and Pharmaceutical industries.

Requirements: The Biochemical Engineering Certificate consists of two required courses and two elective courses.

Required Courses

Fall Semester (even years)	CHE 8588 Biochemical Engineering I
Spring Semester (odd years)	CHE 8589 Biochemical Engineering II

Elective Courses: Select two courses from the following list, subject to the approval of the Chemical Engineering Department.

Select one of the following:

CHE 8586	Biomaterials and Drug Delivery
CHE 7787	Biopharm Facility Design
ME 7700	Transport Phenomena in Biological Systems

Select one of the following:

	Any 2 nd Elective course in the list of electives, above
CHE 8564	Fluid Dynamics
CHM 7693	Advanced Biochemistry (with permission of the CHE and CHM depts.)

This sequence of courses will be offered at a frequency of approximately once every two years. A student may start the sequence at any time and complete the certificate in more than two years. The courses may be taken in any order, although it is recommended that CHE 8588 and CHE 8589, Biochemical Engineering I and II be completed in consecutive semesters. Students with a grade point average of 3.00 or above in the four approved courses will receive a certificate indicating the successful completion of the Biochemical Engineering Certificate.

COMMUNICATION SYSTEMS ENGINEERING CONCENTRATION CERTIFICATE

The concentration certificate in **Communication Engineering**, offered by the Department of **Electrical and Computer Engineering**, covers communication theory, communication electronics and digital communications needed to design and implement systems for diverse applications including space and satellite communications, data communications, telecommunications, and computer communications.

Requirements: The Communication Systems Engineering Concentration Certificate is awarded upon satisfactory completion of three required courses and two elective courses. Students electing this concentration are expected to have a background in digital signal processing equivalent to ECE 8231.

Required Courses

ECE 8072	Statistical Signal Processing
ECE 8700	Communications Systems Engineering
ECE 8770	Topics in Digital Communications

Elective Courses: Select two from the following list.

ECE 8247	Multimedia Systems
ECE 8710	Radar Systems
ECE 8750	Communication Electronics
ECE 8771	Information Theory and Coding Digital Communications
ECE 8787	Communication Networks
ECE 9090	Electrical or Computer Engineering Project

For additional information on this concentration certificate, contact Dr. Bijan Mobasseri at 610-519-4958 or by email to: bijan.mobasser@villanova.edu.

COMPUTER ARCHITECTURE CONCENTRATION

A concentration in **Computer Architecture**, offered by the Department of **Electrical and Computer Engineering**, covers the theory, design, implementations, and applications of computer architectures. Design methodology of computer architectures is rapidly changing due to advancement in microprocessors, integrated circuits and neural and VLSI circuits. Applications of computer architectures are many, including supercomputers, signal processing, communication systems, control systems, and large scale information processing systems.

Requirements: The Computer Architecture Concentration Certificate is awarded upon satisfactory completion of four required courses and one elective course. Students are expected to have a strong background in design and microprocessors at the undergraduate level.

Required Courses

ECE 8405	Computer Organization and Design
ECE 8440	Hardware System Design and Modeling
ECE 8445	Advanced Computer Architecture
ECE 8473	Operating Systems and Programming

Elective Courses: Select one course from the following list.

ECE 8407	Computer Arithmetic Algorithms and Implementations
ECE 8426	Advanced Microprocessors
ECE 8428	Switching and Automata Theory
ECE 8448	Embedded Systems Architecture
ECE 9090	Electrical or Computer Engineering Project

For additional information on this concentration certificate, contact Dr. Edward Kresch at 610-519-7098 or by email to: edward.kresch@villanova.edu.

ELECTRIC ENERGY SYSTEMS CONCENTRATION CERTIFICATE

A concentration certificate in **Electric Energy Systems**, offered by the Department of **Electrical and Computer Engineering**, supports the training and continuing education needs of the engineers who design and operate electric energy systems. It provides a broad range of courses that pertain to theory and practical considerations of electric energy systems.

Requirements: The Electric Energy Systems Concentration Certificate is awarded upon satisfactory completion of four required courses and one elective course. Students are expected to have completed introductory coursework in circuit analysis.

Required Courses

ECE 7805	Electric Machinery
ECE 8810	Power System Modeling
ECE 8820	Power System Dynamics
ECE 8320	Control Systems Engineering

Elective Courses: Select one course from the following list.

ECE 7000	Renewable Energy Sources
ECE 8224	Reliability Theory and Practice
ECE 8342	Digital Control Systems
ECE 8580	Power Electronics
ECE 8805	Advances Electric Machinery
ECE 8830	Electric Drives
ECE 9090	Electrical or Computer Engineering Project*
ECE 9900	Special Topics*
EGR 7850	Electrochemical Power Sources

* - requires approval of student's academic advisor

For additional information on this concentration certificate, contact Dr. Frank Mercede at 610-519-4982 or by email to: frank.mercede@villanova.edu.

ELECTRO-MECHANICAL SYSTEMS CERTIFICATE

The **Electro-Mechanical Systems Certificate**, administered jointly by the Departments of **Electrical and Computer Engineering Department** and **Mechanical Engineering**, develops a core framework for engineers concerned with the design, implementation, control and operation of Electro-Mechanical systems. The engineering aspects of such systems which include modeling, simulation, instrumentation, compensation and control are emphasized in this certificate program. A blend of required and elective courses from the electrical and mechanical engineering disciplines provides a flexible framework for participants to design a curriculum that targets their particular needs and interests.

Requirements: The Electro-Mechanical Systems Certificate is awarded upon satisfactory completion of five courses as follows: (1) ECE 8320 or ME 8401; (2) at least one course from Electrical and Computer Engineering; (3) at least one course from Mechanical Engineering. Other restrictions are mentioned below.

Required Courses: Select one from the following list.

ECE 8320	Control Systems Engineering
Or	
ME 8401	Control Systems Engineering

Elective Courses: Select four courses from the following list.

ECE 7525	Electronic Measurement and Conversion
ECE 8007*	Matrix Theory
ECE 8224	Reliability Theory and Practice
ECE 8342	Digital Control Systems
ECE 8416	Fuzzy Logic with Engineering Applications
ECE 8580	Power Electronics
ECE 8800	Electric Machinery
ECE 9900**	Special Topics
ME 7000*	Advanced Engineering Analysis
ME 7204	Computer-Aided Analysis of Multibody Systems
ME 7205	Advanced Dynamics
ME 7206	Dynamics of Rotating Machinery
ME 8204	Robotics – Analysis and Control
ME 8207	Vibration Analysis
ME 9010**	Special Topics

*Only one of these courses may be counted toward the Electro-Mechanical Systems Certificate.

**This course will be accepted only if the topic is related to the Electro-Mechanical Systems Certificate.

For additional information on this concentration certificate, contact Dr. Frank Mercede.

ENVIRONMENTAL PROTECTION IN THE CHEMICAL PROCESS INDUSTRY

A concentration of courses introducing the fundamentals of **Environmental Protection** as applied in the CPI is available to students matriculating in the College of Engineering, administered by the Department of **Chemical Engineering**. Students interested in the Environmental Protection concentration should make application to a specific engineering department. Once accepted into a program, they should contact the chemical engineering department regarding the Environmental Protection Certificate.

Requirements: The Environmental Protection Concentration Certificate is awarded upon satisfactory completion of four required courses.

Required Courses

CHE 8572	Separation Processes II
CHE 8561	Air Pollution Control
CHE 8591	CHE 8591 Industrial Waste Management
CEE 7011	CEE 7011 Hazardous Waste Management (or other approved elective)

Students may take the courses in any order, and may take more than two years to complete the program. A student whose grade average in the above four courses is 3.00 or better will receive a certificate indicating successful completion of the Environmental Protection Concentration.

HIGH FREQUENCY SYSTEMS CONCENTRATION CERTIFICATE

The concentration certificate in **High Frequency Systems**, offered by the Department of **Electrical and Computer Engineering**, covers material in microwave theory and techniques, antennas and photonics. This material provides students the tools to understand, design and implement telecommunication systems for a variety of terrestrial and space applications.

Requirements: The High Frequency Systems Concentration Certificate is awarded upon satisfactory completion of four required courses and one elective course.

Required Courses

ECE 8562	Introduction to Photonics
ECE 8670	Microwave Theory and Techniques I
ECE 8671	Microwave Theory and Techniques II
ECE 8675	Antenna Theory and Design I

Elective Courses: Select one from the following list.

ECE 8565	Microwave Integrated Circuits
ECE 8568	Optoelectronic Devices and Circuits
ECE 8676	Antenna Theory and Design II

For additional information on this concentration certificate, contact Dr. Robert Caverly at 610-519-5660 or by email to: caverly@ece.villanova.edu.

INTELLIGENT SYSTEMS CONCENTRATION CERTIFICATE

The concentration certificate in **Intelligent Systems**, offered by the Department of **Electrical and Computer Engineering**, focuses on recent methodologies such as fuzzy logic, neural networks, genetic programming, and expert systems. The content of the concentration may also be referred to as artificial intelligence, soft computing, or computational intelligence. Application areas for these new engineering methodologies range from nonlinear process control, fault diagnosis, and smart appliances to speech recognition, planning under uncertainty, signal processing, decision-making, and classification.

Requirements: The Intelligent Systems Concentration Certificate is awarded upon satisfactory completion of four courses.

Select four courses from the following list

ECE 8402	Intelligent Systems Programming
ECE 8412	Neural Networks
ECE 8416	Fuzzy Logic with Engineering Applications
ECE 8429	Topics in Intelligent Systems
CSC 8520	Artificial Intelligence
CSC 8750	Expert Systems

Depending on the topics, ECE 8429 Topics in Intelligent Systems may be taken more than once, with permission.

For additional information on this concentration, contact Dr. Anthony Zygmunt by calling 610-519-7099, or by sending email to: anthony.zygmunt@villanova.edu

MACHINERY DYNAMICS CERTIFICATE

The certificate in **Machinery Dynamics** is administered by the Department of **Mechanical Engineering**.

Requirements: The Machinery Dynamics Certificate is awarded upon the satisfactory completion of four courses.

Select four courses from the following list

ME 7000*	Advanced Engineering Analysis
ME 7040	Introduction to Finite Elements with Applications
ME 7204	Computer-Aided Analysis of Multibody Systems
ME 7205	Advanced Dynamics
ME 7206	Dynamics of Rotating Machinery
ME 8207	Vibration Analysis
ME 8401	Control Systems Engineering
ME 8406	Nonlinear Dynamics

*Note that while ME 7000 may be used toward various certificate programs, it cannot be counted toward two different certificates.

NONLINEAR DYNAMICS AND CONTROL CERTIFICATE PROGRAM

The College of Engineering offers a certificate program in **Nonlinear Dynamics and Control**, administered jointly by the Departments of **Chemical Engineering, Electrical and Computer Engineering, and Mechanical Engineering**. It includes a concentrated study of modern principles with both breadth and depth of coverage being emphasized. The research program at the Center for Nonlinear Dynamics & Control (CENDAC) serves to complement the courses.

The certificate program is open to all individuals who possess a Bachelor's degree in either Engineering or some related field. Applications for admission are assessed on the basis of undergraduate record and related work experience. As a non-matriculated student, credits could be transferred towards a Master's Degree (in ChE, ECE, or ME), contingent on the individual satisfying the admission requirements of the department.

Requirements: The Nonlinear Dynamics and Control Certificate is awarded upon satisfactory completion of four courses.

Required Course

ECE 8301	Control Systems Engineering
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Elective Courses: The remaining three courses may all be chosen from the following list of Nonlinear Dynamics and Control course offerings.

EGR 8302	Digital Control
EGR 8303	Optimal & Model Predictive Control
EGR 8304	Nonlinear Control
EGR 8305	System Identification
EGR 8306	Nonlinear Dynamics
EGR 8309	Advanced Topics in Control

One of the four courses may be a graduate level mathematics course offered by the ChE, ECE, or ME departments from the following list.

CHE 8579	Applied Mathematics for Chemical Engineers
ECE 8001	Engineering Mathematics
ECE 8002	Engineering Mathematics
ECE 8007	Matrix Theory
ME 7000	Advanced Engineering Analysis

One of the four courses may be a graduate level control or optimization course offered by the ChE, ECE, or ME departments from the following list.

CHE 8585	Optimization
ME 8002	Asymptotics for Engineers
ME 8204	Robotics Analysis and Control

One Control and Dynamics related special topics course in the ChE, ECE, or ME departments may also be counted toward the certificate with prior permission.

SUSTAINABLE ENGINEERING CERTIFICATE

THERMOFLUID SYSTEMS CERTIFICATE

The certificate in **Thermofluid Systems** is administered by the Department of **Mechanical Engineering**.

Requirements: The Thermofluid Systems Certificate is awarded upon successful completion of any four of the following ten courses.

Select four courses from the following list

ME 7000*	Advanced Engineering Analysis
ME 7038	Introduction to Computational Fluid Mechanics
ME 7103	Advanced Thermodynamics
ME 7600	Thermal Management of Electronics
ME 7700	Transport Phenomenon In Biological Systems
ME 8103	Advanced Fluid Mechanics
ME 8110	Conduction Heat Transfer
ME 8120	Convection Heat Transfer
ME 8130	Radiation Heat Transfer
ME 8250	Microscale Heat Transfer

*Note that while ME 7000 may be used toward various certificate programs, it cannot be counted toward two different certificates.

URBAN WATER RESOURCES DESIGN CERTIFICATE

The Water Resources and Environmental Engineering Program of the Department of **Civil and Environmental Engineering** offers a **Certificate Program in Urban Water Resources Design** geared to civil engineers and water resource professionals engaged in the design of urban hydraulic and hydrologic systems.

Candidates interested in the Certificate must apply for admission into either the MSCE or MSWREE degree program.

Requirements: The Urban Water Resources Design Certificate is awarded upon satisfactory completion of four graduate courses.

Required Courses

CEE 8501	Surface Water Hydrology
CEE 8503	Open Channel Hydraulics
CEE 8508	Urban Hydrology and Storm Water Management

Elective Course: Any of the remaining Water Resources Engineering courses

WIRELESS AND DIGITAL COMMUNICATIONS CONCENTRATION CERTIFICATE

The **Wireless and Digital Communications Certificate**, offered by the Department of **Electrical and Computer Engineering**, covers the theoretical background and practice of wireless and digital communications. Topics include: digital modulation, wireless systems, detection, sequence estimation, channel equalization, array processing for wireless communications, multimedia systems, information theory, source and channel coding.

Requirements: The Wireless and Digital Communications Certificate consists of five courses. Two core courses are required unless the student already has a comparable background. After fulfilling the core requirements, the balance of five courses is to be taken from the list of elective courses. Related courses can be substituted for the elective courses only upon approval of the ECE Graduate Coordinator. Students electing this certificate are expected to have a background in signal and system theory comparable to ECE 3220.

Required Courses

ECE 8072	Statistical Signal Processing
ECE 8700	Communication System Engineering

Elective Courses

ECE 8247	Multimedia Systems
ECE 8272	Array Processing for Wireless Communications
ECE 8708	Wireless Communications
ECE 8770	Topics in Digital Communications
ECE 8771	Information Theory and Coding for Digital Communications

For additional information on this concentration certificate, contact Dr. Kevin Buckley at 610-519-5658 or by email to: buckley@ece.villanova.edu.

RESEARCH CENTERS

The College of Engineering is dedicated to supporting the research activities of its faculty and students. This research is conducted through cooperation with government and industry. The college has three research centers: The Center for Advanced Communications, Center for Advancement of Sustainability in Engineering and the Center for Nonlinear Dynamics and Control.

[THE CENTER FOR ADVANCED COMMUNICATIONS](#)

www.engineering.villanova.edu/cac/

The Center for Advanced Communications (CAC) is the only entity on campus which pursues extensive and rigorous research and development in the broad areas of communications including Wireless and Digital Communications, High Resolution Imaging, Smart Antennas and Space-Time Processing, Interference Mitigation in Broadband Communication Platforms, Innovative Antenna Design, Computational Electromagnetics, Microwave and RF Microelectronics, GNSS and Satellite Navigation Technology, Linear and Nonlinear Modeling of Devices, Multimedia and Communication Security.

The Center's main activities aim at facilitating the transformation of knowledge into innovations, which create new wealth and strengthen the regional economy. This is accomplished by planning and implementing effective models that create a community utilizing research, technology and education. Since its inception in 1990, the Center has provided an integrated environment for university, industry, and government to focus on computational, informational, and communication issues. The projects undertaken by the Center are typically headed by professors in the college of engineering, and involve undergraduate and graduate students, research professors, and postdoctoral research fellows. Through strong collaborations with different academic institutions, in the US and overseas, the Center for Advanced Communications provides our students with the opportunity to discuss their work and interact with researchers from the US and abroad.

The CAC is a self-sustaining research center whose projects are typically sponsored by Pennsylvania State agencies, federal government agencies, and the private sector. The benefits to our sponsors include a regional and stable base of technology expertise, economic growth and job creation, cost-effective R & D, a strategic relationship in Information and Communication Technologies, and a pool of highly qualified students.

The Center for Advanced Communications has gained international recognition of its research work in the area of signal processing and communications. The CAC has established technical collaborations with several institutions abroad. Since 2003 nine Memorandums of Understanding have been signed. These agreements allow parties to exchanges ideas, real data measurements, technical visits, and joint supervision of graduate students. Also, the CAC has become the US representative on the NATO Task Force on Through-the-Wall Radar Imaging (TWRI). Applications of TWRI include search for earthquakes and avalanche victims and assist law enforcement officers in curbing crimes and apprehending outlaws.

The CAC's computer and measurements facilities are the envy of region. The Center has established four state-of-the-art laboratories.

- The Antenna Research Lab (ARL) houses an anechoic chamber for antenna testing which is unique in the Delaware Valley.

- The Radar Imaging Laboratory (RIL) is equipped with the capabilities for examining and providing proof-of-concept of existing and newly-devised imaging techniques using real data.
- The Wireless Communications and Positioning Laboratory (WCPL) provides the measurement and data collection capabilities combined with analyses and signal syntheses tools needed for the CAC to stay on the top of cellular telephony, wireless connectivity, and GPS technologies.
- Radio Frequency Identification Laboratory (RFID Lab) hosts testing facilities for RFID products, and supports the evaluation of RFID tag and RFID-assisted tagged localization methods, collision avoidance techniques, and signal propagation characteristics.

The labs provide hands-on experience and familiarity of key simulation tools that are needed to prepare the students to join the workforce in government and private sectors.

For additional information, please contact: Dr. Moeness Amin, Director, Center for Advanced Communications, Villanova University, 800 Lancaster Avenue, Tolentine 119, Villanova, PA 19085, Telephone 610-519-4263, FAX 610-519-6118, moeness.amin@villanova.edu

CENTER FOR ADVANCEMENT OF SUSTAINABILITY IN ENGINEERING

CENTER FOR NONLINEAR DYNAMICS AND CONTROL

The Center for Nonlinear Dynamics & Control (CENDAC) is an interdisciplinary research center in the College of Engineering with a focus on applying advanced nonlinear theoretical, numerical and experimental techniques to solve practical real-world problems. The research at the Center is performed by experts drawn from the four engineering departments, visiting and postdoctoral researchers, and graduate and undergraduate students. Frequently, the researchers have an industrial partner who provides a research and educational focus to the projects.

The Center's current expertise is in the areas of automotive applications, robotics, electromechanical systems, novel materials and design, and nonlinear process control and optimization. Experimental facilities include state of the art fast response gas analysis equipment for novel control of automotive processes, an atomic force microscope for studying material properties and nano-mechanics, a host of dynamic analysis equipment, robotics kits, and advanced electronics laboratories.

CENDAC aims to develop and transfer technology to the industry consistent with the industry's needs and vision ultimately enhancing their competitiveness. Hence, the Center maintains a close collaboration with industries. The Center's current projects are funded by federal agencies such as the Office of Naval Research, the National Science Foundation and industries such as Ford Motor Company.

Education and training of tomorrow's engineers is a central theme of the Center, and hence, students are an integral component of the Center's activities. CENDAC provides research experience for graduate and undergraduate students in the focus areas by awarding research assistantships to qualified students enrolled in the College of Engineering graduate program. The Center also provides a limited number of summer internships.

For additional information, please contact: Dr. J.C. Peyton Jones, Director, CENDAC Villanova University, 800 Lancaster Avenue, Villanova, PA 19085, j.peyton-jones@villanova.edu.

COLLEGE OF ENGINEERING DEPARTMENTS

The following departmental sections address graduate faculty, departmental regulations and procedures, degree requirements, and special programs.

CHEMICAL ENGINEERING

Chair and Professor: Weinstein

Professors: Joye, Kelly (C.M.), Muske, **Punzi

Associate Professors: *Kelly (Wm.), Ritter, *Skaf

Assistant Professors: Comolli, *Smith

Emeritus Professors: Myers, Sweeny

*Member Graduate Committee

**Chair, Graduate Committee

DEPARTMENTAL REQUIREMENTS

The Chemical Engineering Department offers full-time and part-time programs leading to the degree of Master of Science in Chemical Engineering (MSChE). The requirements and content of the two programs are identical.

The curriculum is built around a core of fundamental chemical engineering subjects. Added to the core are additional basic or applied courses best suited to the needs of the individual student. The student selects his own course sequence; however, the distribution must conform to written departmental guidelines and be approved by his advisor. There is no language requirement.

The program consists of at least 30 credits of course work, of which a maximum of six credits may be replaced by an independent study project. This project, if elected, will be guided by a member of the department faculty. The type of project (e.g., experimental research, process design, theoretical analysis, literature survey) will be based on the student's interests and the recommendations of the department's graduate committee. All topics for independent study are subject to review and approval by the department's graduate committee. The student must prepare a formal written report covering the independent study. Full-time students receiving financial aid will be required to carry out an independent study project for six credits and prepare a thesis.

A minimum of 24 credits of the student's course work must be in chemical engineering. The courses selected must conform to the departmental guidelines and form a coordinated program.

Applicants for admission to the MSChE program must ordinarily possess a bachelor's degree in chemical engineering or have met the standard requirements therefore. Students who hold a bachelor's degree in a field other than chemical engineering may apply to the program but, if admitted, will be required to take certain undergraduate courses (which will be specified by the graduate committee of the ChE department) in addition to the program requirements stated previously. The ability to pursue graduate studies must be demonstrated by the applicant's undergraduate record and/or recommendations.

The applicant for admission must submit a formal application, transcripts from all previous colleges attended, letters of recommendation, and, when requested, Graduate Record Examination scores. Foreign applicants must also give evidence of adequate proficiency in the English language, as determined by the TOEFL examination score.

CERTIFICATE PROGRAMS

The Chemical Engineering Department offers concentration certificates in

- **Biochemical Engineering**
- **Environmental Protection in the Chemical Process Industry**

A full description of each certificate can be found in the Certificate section of this bulletin.

Admission requirements are the same, unless specified, as those for the graduate degree programs. Students will be required to meet all the course prerequisites and maintain a Grade Point Average of at least 3.00. Courses completed for the Certificate could be applied toward a Master's degree should the student wish to continue.

CIVIL AND ENVIRONMENTAL ENGINEERING

Chair and Professor: *Chadderton, *Dinehart, Traver

Associate Professors: *Duran, Gross, Welker, Yost

Assistant Professors: **Glynn, Hampton, Komlos, *McCarthy, Radlinska, Wadzuk

Adjunct Professors: Baehr, Browne, Lowe, Wujcik

Adjunct Associate Professors: Falcone, Najjar

Adjunct Assistant Professors: McFadden, Pierri, Radzinski

*Member Graduate Committee

**Chair, Graduate Committee

PROGRAM OBJECTIVES

Graduate programs leading to the degrees of Master of Science in Civil Engineering (MSCE) and Master of Science in Water Resources and Environmental Engineering (MSWREE) are offered by the Department of Civil and Environmental Engineering.

The departmental evening graduate programs provide practicing professionals an opportunity to pursue advanced study on either a part-time or full-time basis. The programs maintain a balance between theory and application, stress modern engineering methods for the solution of detailed and complex problems, and emphasize the concepts of analysis and design coupled with engineering judgment.

Students may undertake a program in structural engineering, transportation engineering, water resources and environmental engineering, or an interdisciplinary program of study.

The programs can accommodate the needs and interests of individual students. Each student must develop a Plan of Study prior to the completion of the student's initial semester of graduate study. The Plan of Study is prepared with the help of an assigned faculty advisor and must be approved by the department chairperson.

ADMISSION AND DEGREE REQUIREMENTS

The applicant must demonstrate the ability to master graduate-level studies. The evaluation is based on a review of the formal application submitted, transcripts from all previous colleges attended, and letters of recommendation. Applicants whose native language is not English must also give evidence of adequate proficiency in the English language determined by the TOEFL examination score; results of the Graduate Record Examination, GRE (General Test), must also be submitted.

To earn the MSCE degree, the candidate would normally hold a Bachelor of Science in Civil Engineering (BSCE) degree from an Accreditation Board for Engineering and Technology (ABET) accredited program or its equivalent. A candidate with a degree in another engineering or related field is eligible provided he/she can present evidence of proficiency in mathematics, basic and engineering science, computer literacy, and engineering design consistent with ABET's Criteria for Basic Level Programs. In the absence of such evidence, the candidate will be required to complete the undergraduate engineering design courses and their appropriate undergraduate prerequisites including mathematics, and basic science courses consistent with the BSCE program at Villanova.

A candidate is eligible to pursue the MSWREE degree provided he/she can present evidence of proficiency in mathematics, basic science, and engineering science. In the absence of such evidence, the candidate will be required to complete the following undergraduate prerequisites: four semesters of mathematics through differential equations, two semesters of chemistry, one semester

of Newtonian physics, statics and fluid mechanics.

The undergraduate prerequisites for either of the graduate degrees may be completed in either the day or evening undergraduate programs at Villanova or their equivalent taken elsewhere with departmental approval. Engineering technology courses cannot be used to fulfill undergraduate prerequisites. The undergraduate courses will be in addition to the graduate courses required for the graduate degree.

A minimum of 30 earned semester credits of graduate work is required and a minimum of 21 graduate credits must be in Civil and Environmental Engineering courses. A Plan of Study must be approved by the advisor and chairperson prior to the completion of the student's initial semester of graduate study. For approval, the plan must indicate a topical focus and direction commensurate with a master's program. Guided by his/her advisor, a student may select a Plan of Study consisting of: (1) thirty earned credits of graduate courses, (2) a thesis track consisting of twenty-one earned credits of graduate courses, a three-credit research/investigation course and a six-credit thesis, or (3) twenty-seven earned credits of graduate courses, and a three-credit research/investigation course. Students are encouraged, but not required, to write a Master of Science thesis.

THESIS POLICY AND PROCEDURES

The following outline contains the policies and procedures applicable to the graduate students who have elected the thesis option.

- A. The student, after consultation with appropriate faculty, chooses a faculty member who agrees to become the research/investigation course advisor.
- B. The research topic and scope in CEE 9030 Research/Investigation must be submitted in writing to the Research/Investigation course advisor for approval prior to registration.
- C. At the completion of CEE 9030, the final written document will be submitted as a thesis proposal or a term paper for grade. CEE 9030 must be completed prior to CEE 9031 registration.
- D. There are two options regarding thesis and the completion of CEE 9030:
 1. If the student and the research/investigation course advisor agree that the results of the research do not constitute a viable thesis proposal, the student will receive a grade for CEE 9030 but will not register for thesis credits.
 2. If the thesis proposal is acceptable to the student and the research/investigation course advisor and approved by the chairperson, the student will receive a grade for CEE 9030 and may then register for six credits of thesis.

In rare instances a student may proceed directly into CEE 9031 without registering for the prerequisite CEE 9030. The student must have the permission of his/her thesis advisor and the department chairperson to omit CEE 9030.

STRUCTURAL ENGINEERING PROGRAM

The department offers extensive graduate coursework in structural engineering with courses emphasizing structural design, mechanics and analysis, structural dynamics, and other related subjects. Students concentrating in structural engineering pursue the MSCE degree.

Under the guidance of the advisor, a student will arrange a Plan of Study. A student concentrating in structural engineering must satisfactorily complete:

- 1) Two courses from the Structural Design group listed below, one of which must be CEE 8435 Reinforced Concrete or CEE 8437 Structural Steel
- 2) Two courses from the Mechanics and Analysis group listed below
- 3) CEE 8434 Structural Dynamics

Students shall develop the remainder of their Plans of Study from the courses listed in the four areas below.

Structural Design

CEE 7400	Design of Bridges
CEE 7401	Wood and Masonry Structures
CEE 8435	Reinforced Concrete
CEE 8436	Prestressed Concrete
CEE 8437	Structural Steel
CEE 8438	Structural Connections

Mechanics and Analysis

CEE 7400	Design of Bridges
CEE 8420	Composites for Infrastructure
CEE 8430	Finite Element Analysis
CEE 8441	Advanced Mechanics of Materials
CEE 8442	Advanced Structural Mechanics
CEE 8443	Advanced Structural Analysis
ME 7040	Introduction to Finite Element Analysis
ME 8200	Elasticity and Stress Analysis
ME 8350	Applied Fracture Mechanics

Structural Dynamics

CEE 8414	Earthquake Engineering
CEE 8434	Structural Dynamics
ME 8207	Vibration Analysis

Structural Engineering Electives

CEE 7303	Pavement Design and Dynamic Response
CEE 7402	Forensic Engineering
CEE 8102	Foundation Engineering
CEE 8105	Advanced Soil Mechanics
CEE 8439	Civil Engineering Materials
ME 7501	Reinforced (Composite) Materials
ME 7502	Fiber Composite Structures – Analysis and Design
ME 8302	Mechanical and Thermal Behavior of Solids

A student may select appropriate additional courses outside the Department of Civil and Environmental Engineering with the approval of the advisor.

GEOTECHNICAL ENGINEERING PROGRAM

A student interested in geotechnical engineering would typically pursue an MSCE degree with an interdisciplinary focus that combines geotechnical engineering with one of the other four disciplines, i.e., environmental, structural, transportation or water resources engineering. A graduate student with an environmental, structural, transportation or water resources focus could, with the consent of the advisor, include geotechnical courses in his/her Plan of Study. Geotechnical courses include:

Geotechnical Engineering

CEE 8102	Foundation Engineering
CEE 8103	Geosynthetics
CEE 8104	Geoenvironmental Engineering
CEE 8105	Advanced Soil Mechanics
CEE 8311	Environmental Geology
CEE 8510	Groundwater Hydrology

TRANSPORTATION ENGINEERING PROGRAM

The department offers a multi-disciplinary program for study and research in the field of transportation and in the related areas of planning, management, environmental studies and other civil engineering disciplines. Students concentrating in transportation engineering pursue the MSCE degree. There are nine core transportation courses. As indicated below, students must take at least six of the core courses. Additional recommended courses are listed below and comprise the four elective courses. Under the guidance of the advisor, a student will develop a Plan of Study from the following courses:

Core Transportation Engineering Courses -- (Students are required to take six of these courses.)

CEE 7303	Pavement Design and Dynamic Response
CEE 8201	Urban Transportation Engineering
CEE 8202	Transportation Planning and Operations
CEE 8203	Traffic Engineering
CEE 8205	Highway Safety
CEE 8206	Construction Project Management
CEE 8207	Design of Sustainable Transportation Systems
CEE 8303	Urban Planning
CEE 8439	Civil Engineering Materials

CEE Elective Courses in Transportation Engineering

CEE 7001	Business Basics for Engineers
CEE 7002	Management for Engineers
CEE 7400	Design of Bridges
CEE 7402	Forensic Engineering
CEE 8102	Foundation Engineering
CEE 8103	Geosynthetics
CEE 8105	Advanced Soil Mechanics
CEE 8311	Environmental Geology
CEE 8420	Composites for Infrastructure
CEE 8435	Reinforced Concrete
CEE 8508	Urban Hydrology and Storm Water Management
CEE 8601	Special Topics in Engineering

Other Elective Courses in Transportation Engineering

ME 7040	Introduction to Finite Element Analysis
ME 8350	Applied Fracture Mechanics
MAT 7404	Statistical Methods I
MAT 7405	Statistical Methods II
MAT 8435	Mathematical Modeling

A student may select appropriate additional courses outside the Department of Civil and Environmental Engineering with the approval of the advisor.

WATER RESOURCES AND ENVIRONMENTAL ENGINEERING PROGRAM

Students majoring in this interdisciplinary program of study and research may elect from courses in environmental engineering, and hydraulic engineering and hydrology. A student in this program who has BSCE degree or its equivalent would typically pursue a MSCE degree. A student with a baccalaureate degree in a related academic field is eligible to pursue the MSWREE degree provided that he/she can provide evidence of proficiency in the subjects noted in Department Admission and Degree Requirements. A student with a BSCE can choose either the MSCE or MSWREE. The requirements for the MSWREE degree are:

- EE requirements: 2 courses from the following; CEE 7502, 7511, 7513, 7701, 8707, 8708
- WREE requirements: 2 courses from the following: CEE 7111* 8501, 8502, 8503, 8507, 8510
- All students are required to take one of the following; CEE 8502, 8507, 8707, 8708
- *CEE 7111 is only for students who do not have a BSCE or its equivalent.

Under the guidance of the advisor, a student will develop a Plan of Study from the following courses:

Environmental Engineering

CEE 7011	Hazardous Waste Management
CEE 7502	Introduction to Environmental Engineering Processes
CEE 7511	Microbiology for Environmental Engineers
CEE 7513	Fate and Transport of Contaminants
CEE 7514	Industrial Pollution Prevention
CEE 7701	Aquatic Chemistry for Environmental Engineers
CEE 7829	Principles of Sustainable Development for Industry/Society
CEE 8707	Physical/Chemical Treatment Processes
CEE 8708	Biological Treatment Processes

Water Resources Engineering

CEE 7010	Lake, Stream & Wetland Ecology
CEE 7111	Introduction to Hydraulic Engineering and Hydrology
CEE 7211	Water Resource Planning and Management
CEE 8501	Surface Water Hydrology
CEE 8502	Watershed Modeling
CEE 8503	Open Channel Hydraulics
CEE 8507	Environmental Fluids
CEE 8508	Urban Hydrology and Storm Water Management
CEE 8510	Groundwater Hydrology
CEE 8512	River Mechanics and Engineering

Elective Courses

CEE 7001	Business Basics for Engineers
CEE 7002	Management for Engineers
CEE 8103	Geosynthetics
CEE 8104	Geoenvironmental Engineering
CEE 8311	Environmental Geology
CEE 8601	Special Topics in Engineering
CHE 8561	Air Pollution Control

A student may select appropriate additional courses outside the Department of Civil and Environmental Engineering with the approval of the advisor.

CERTIFICATE PROGRAMS

The Civil and Environmental Department offers a concentration certificate in

- **Urban Water Resources Design.**

A full description of the certificate can be found in the Certificate section of this bulletin.

Admission requirements are the same, unless specified, as those for the graduate degree programs. Students will be required to meet all the course prerequisites and maintain a Grade Point Average of at least 3.00. Courses completed for the Certificate could be applied toward a Master's degree should the student wish to continue.

ELECTRICAL AND COMPUTER ENGINEERING

Chair and Professor: Singh

Professors: *Amin, **Buckley, Caverly, *Hoorfar, Mobasseri, *Peyton-Jones, *Zygmunt

Associate Professors: Bukowski, DiMeo, ++Kresch, +Perry,

Assistant Professors: +Gupta, Jupina, Konyk, +Kulkarni, Mercede, +Wang, *Wynne

Adjunct Professors: Chitrapu, Hepler, Rubinfield

Adjunct Associate Professors: Adler, McCarthy, Pallegadda, Ruggeri

Emeritus Professor: Kozikowski

*Member Electrical Engineering Graduate Committee

**Chair, Electrical Engineering Graduate Committee

+ Member Computer Engineering Graduate Committee

++Chair, Computer Engineering Graduate Committee

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING (MSEE)

PROGRAM OBJECTIVES

The main objective of the Graduate Program in Electrical and Computer Engineering is to provide an opportunity for students to investigate any one of a wide range of topics and develop a professional competence in associated advanced engineering concepts and techniques. It is also an objective of the program to provide students with an in-depth background that will be the basis for an individual's future technical and scientific growth and development.

ADMISSION REQUIREMENTS

Admission to the MSEE program will be granted to qualified applicants who hold a bachelor's degree in Electrical Engineering (EE) from an accredited institution. Outstanding students with a bachelor's degree in other engineering fields or in applied sciences will also be considered for admission. Students may be required to remove deficiencies before registering for graduate courses. Applicants are also expected to meet requirements for admission to the College of Engineering. The Graduate Record Examination is required for all individuals receiving their bachelor's degree outside of the United States. The TOEFL (Test of English as a Foreign Language) Examination is required of all students whose native language is not English.

PROGRAM REQUIREMENTS

A minimum of 30 semester credit hours must be successfully completed for the MSEE degree. Requirements are summarized as follows:

	Thesis Option	Non-Thesis Option
MSEE Specialty Courses	15 credits	21 credits
MSEE Elective Courses	6 credits	9 credits
Independent Study Course	3 credits	Not applicable*
Thesis	6 credits	Not applicable
Total credit hours	30 credits	30 credits

* Graduate students electing the non-thesis option may substitute three credits of independent study for one Recommended Elective Course.

COURSE REQUIREMENTS

Electrical Engineering courses must be chosen from the MSEE course offering list. Students may choose courses from Electrical Engineering, Computer Engineering, Computer Science, and other appropriate programs to satisfy the requirement of MSEE Elective Courses.

MSEE SPECIALTY COURSES

The following is a list of typical EE Specialty Areas. Students prepare a course plan to meet their career objectives by choosing courses from one or more of the listed Specialty Areas. It is strongly recommended that students consult faculty advisors in constructing their course plan to satisfy the requirements for the MSEE.

Communications and Signal Processing

ECE 7428	Computer Communication Networks
ECE 7710	Real-Time Digital Signal Processing
ECE 7750	Communication Electronics
ECE 8007	Matrix Theory
ECE 8072	Statistical Signal Processing
ECE 8231	Digital Signal Processing
ECE 8233	Filter Banks, Wavelets, and Subband Coding
ECE 8234	Image Processing
ECE 8247	Multimedia Systems
ECE 8270	Topics in Digital Signal Processing
ECE 8272	Array Processing for Wireless Communications
ECE 8277	Time Frequency Signal Analysis and Spectrum Estimation
ECE 8464	VLSI Array Processors
ECE 8477	Computer Vision
ECE 8478	Pattern Recognition
ECE 8700	Communication Systems Engineering
ECE 8708	Wireless Communications
ECE 8710	Radar Systems
ECE 8760	Optical Communications
ECE 8770	Topics in Digital Communications
ECE 8771	Information Theory and Coding Digital Communications
ECE 8772	Satellite Communication Systems
ECE 8787	Communications Networks

Microwave Systems, Photonics and Antennas

ECE 8001	Engineering Mathematics
ECE 8560	Mixed Signal IC Design
ECE 8562	Introduction to Photonics
ECE 8565	Microwave Integrated Circuits
ECE 8566	RFIC Design
ECE 8568	Optoelectronic Devices and Circuits
ECE 8601	Engineering Electromagnetics I (Intermediate)
ECE 8602	Engineering Electromagnetics II (Advanced)
ECE 8670	Microwave Theory and Techniques I
ECE 8671	Microwave Theory and Techniques II
ECE 8675	Antenna Theory and Design I
ECE 8676	Antenna Theory and Design II
ECE 8760	Optical Communications

Solid State Devices and Electronics

ECE 7500	Fundamentals of Solid State Electronics
ECE 7505	Electronic Properties of Materials
ECE 7525	Electronic Measurements and Conversion
ECE 7545	Microelectronic Fabrication
ECE 7550	Linear Integrated Electronics I
ECE 7590	Microelectromechanical Systems
ECE 8515	Active Filter Design
ECE 8525	Sensors
ECE 8545	Digital Integrated Circuits
ECE 8550	Linear Integrated Electronics I
ECE 8555	Linear Integrated Electronics II
ECE 8560	Mixed Signal IC Design
ECE 8565	Microwave Integrated Circuits
ECE 8566	RFIC Design
ECE 8568	Optoelectronic Devices and Circuits
ECE 8580	Power Electronics

Intelligent Systems and Control

ECE 8224	Reliability Theory and Practice
ECE 8320	Control Systems Engineering
ECE 8342	Digital Control Systems
ECE 8380	Advanced Topics in Control System Design
ECE 8402	Intelligent Systems Programming
ECE 8412	Neural Networks
ECE 8416	Fuzzy Logic with Engineering Applications
ECE 8429	Topics in Intelligent Systems

Digital Systems

ECE 8405	Computer Organization and Design
ECE 8425	Microprocessors and Microcomputers
ECE 8426	Advanced Microprocessors
ECE 8440	Hardware System Design and Modeling
ECE 8445	Advanced Computer Architecture
ECE 8448	Embedded Systems Architecture
ECE 8455	Field Programmable Devices
ECE 8460	VLSI Design
ECE 8545	Digital Integrated Circuits

Electric Energy Systems and Control

ECE 7000	Renewable Energy Policy
ECE 7800	Renewable Energy Systems
ECE 7805	Electric Machinery
ECE 8320	Control System Engineering
ECE 8342	Digital Control Systems
ECE 8380	Advanced Topics in Control System Design
ECE 8580	Power Electronics
ECE 8805	Advanced Electric Machinery
ECE 8810	Power System Modeling
ECE 8820	Power System Dynamics
ECE 8830	Electric Drives
EGR 7850	Electrochemical Power Sources

MSEE ELECTIVE COURSES

Courses listed under the MSEE Specialty Course category may be used to satisfy the MSEE Elective requirement provided they are not used to meet the MSEE Specialty Course requirement. In addition, the following courses offered by the Department of Electrical and Computer Engineering (ECE) may be taken as MSEE Electives. Courses from other programs may also be taken, but require approval.

ECE 7720	Audio-Frequency Systems
ECE 7725	Electronic Music Synthesis
ECE 8001	Engineering Mathematics I
ECE 8002	Engineering Mathematics II
ECE 8240	Computational Algorithms
ECE 8340	Real-Time Control and Robotics
ECE 8407	Computer Arithmetic Algorithms and Implementations
ECE 8408	Mobile Computing and Wireless Networks
ECE 8428	Switching and Automata Theory
ECE 8445	Advanced Computer Architecture
ECE 8450	Digital Systems Hardware and Design
ECE 8470	Introduction to Probabilistic Modeling and Analysis
ECE 8471	Software Reliability
ECE 8473	Operating Systems and Programming
ECE 8475	Object-Oriented Software Construction
ECE 8479	Software Engineering Projects

INDEPENDENT STUDY AND RESEARCH COURSES

ECE 9030	Independent Study
ECE 9031	Research I
ECE 9032	Research II
ECE 9940	Graduate Practicum

SPECIAL TOPICS AND PROJECT COURSES

ECE 9090	Electrical or Computer Engineering Project
ECE 9900	Special Topics in Electrical Engineering
ECE 9905	Supervised Study in Electrical and Computer Engineering

COURSES FOR LOCKHEED MARTIN COMPANY PROGRAM

The following two courses require permission of the Supervisor of Advanced Courses in Engineering, Lockheed Martin Company, King of Prussia, PA. These courses are counted only as approved electives.

ECE 9910	Special Topics in Systems Engineering I
ECE 9920	Special Topics in Systems Engineering II

HOLY FAMILY CAMPUS, NEWTOWN, PA

Currently, ECE graduate courses are being offered at Holy Family College in Newtown, PA. Please contact the ECE graduate office by phone at 610-519-4228 or by email at gradadm@ece.villanova.edu for more information regarding these courses. To learn more about the ECE Department, please visit our web site at www.engineering.villanova.edu/ec.

INTERDIGITAL COMMUNICATIONS CORPORATION

ECE graduate courses are currently being offered at Interdigital Communications Corporation, 781 Third Avenue in King of Prussia, PA. Please contact the ECE graduate office at 610-519-4228 or by email at gradadm@ece.villanova.edu for more information regarding these courses. To learn more about the ECE Department, please visit our web site at www.engineering.villanova.edu/ec.

BAE SYSTEMS

ECE graduate courses are currently being offered at BAE Systems, 305 Richardson Road in Lansdale, PA. Please contact the ECE graduate office at 610-519-4228 or by email at gradadm@ece.villanova.edu for more information regarding these courses. To learn more about the ECE Department, please visit our web site at www.engineering.villanova.edu/ec.

VILLANOVA / NAVAL SURFACE WARFARE CENTER ON-SITE GRADUATE PROGRAM

Villanova University Electrical and Computer Engineering Department and the Naval Surface Warfare Center, Carderock Division have partnered in the development of an on-site graduate education program to better serve the needs of the engineering community at large. The on-site program offers graduate courses at the Philadelphia Naval Business Center, a location central to many engineering based companies in the Philadelphia area. The spirit of the on-site graduate program focuses on making high-quality graduate education readily accessible to the population of working engineers. This must be accomplished within the framework of a demanding work environment and entails: (1) the offering of graduate courses and concentration certificates which address industry's need for employees with cutting-edge engineering expertise; (2) providing ready access through the use of classroom sites near work locations; (3) the use of state-of-the-art communication technology, e.g. teleconferencing and Web based distance learning, to deliver instruction to those on travel and assigned to distant sites. Please contact the ECE graduate office by phone at 610-519-4228 or by email at gradadm@ece.villanova.edu for more information regarding these courses. To learn more about the ECE Department, please visit our website at www.engineering.villanova.edu/ec.

MASTER'S DEGREE THESIS OPTION

Before applying for the thesis option, students must first complete ECE 9030 as preparation. Application for the thesis option requires the submission of a written research proposal outlining the plan of work for the Master's degree thesis and recommendation and approval of the student's research advisor. The chairman's approval is also required. Students who have qualified for the thesis option are required to make an oral presentation prior to graduation.

MASTER OF SCIENCE IN COMPUTER ENGINEERING (MSCPE)

PROGRAM OBJECTIVES

The Graduate Program in Computer Engineering leads to the degree of MSCPE and emphasizes the design and use of computer systems and intelligent systems in engineering applications.

ADMISSION REQUIREMENTS

Admission to the MSCPE program will be granted to qualified students who hold a bachelor's degree in Engineering, Computer Science, or in applied sciences, from an accredited institution. Applicants are expected to meet the requirements for admission to the College of Engineering. The Graduate Record Examination is required for all individuals receiving their bachelor's degree outside of the United States. The TOEFL (Test of English as a Foreign Language) Examination is required of all students whose native language is not English.

PROGRAM REQUIREMENTS

A minimum of 30 semester credit hours must be successfully completed for the Master of Science in Computer Engineering degree. Requirements are summarized as follows:

	Thesis Option	Non-Thesis Option
Computer Engineering Core	9 credits	9 credits
Computer Engineering Electives	9 credits	15 credits
Recommended Electives	3 credits	6 credits
Independent Study	3 credits	Not applicable*
Thesis	6 credits	Not applicable
Total credit hours	30 credits	30 credits

* Graduate students electing the non-thesis option may substitute three credits of independent study for one Recommended Elective Course.

COURSE REQUIREMENTS

When selecting courses, it is the responsibility of the student to make certain that they have satisfied stated course prerequisites.

COMPUTER ENGINEERING (CPE) CORE

A. Hardware (choose one course)

ECE 7711	Hardware DSP
ECE 8425	Microprocessors and Microcomputers
ECE 8426	Advanced Microprocessors
ECE 8440	Hardware System Design and Modeling
ECE 8446	High Performance Processor Architecture
ECE 8455	Field Programmable Devices
ECE 8545	Digital Integrated Circuits

B. Software (choose one course)

ECE 7402	Building Expert Systems
ECE 8402	Intelligent Systems Programming
ECE 8473	Operating Systems and Programming
ECE 8475	Object-Oriented Software Construction

C. Theory (choose one course)

ECE 7428	Computer Communication Networks
ECE 8405	Computer Organization and Design
ECE 8445	Advanced Computer Architecture
ECE 8448	Embedded Systems Architecture

CPE ELECTIVES

Courses listed under the CPE Core category can be used to satisfy the CPE Electives requirement provided they are not used to meet the core requirement. In addition, the following courses can be used to satisfy the CPE Elective requirement.

ECE 7470	Parser Design and Applications
ECE 7505	Electronic Properties of Materials
ECE 7710	Real-Time Digital Signal Processing
ECE 8007	Matrix Theory
ECE 8231	Digital Signal Processing
ECE 8234	Image Processing
ECE 8247	Multimedia Systems
ECE 8407	Computer Arithmetic Algorithms and Implementations
ECE 8408	Mobile Computing and Wireless Networks
ECE 8412	Neural Networks
ECE 8416	Fuzzy Logic with Engineering Applications
ECE 8428	Switching and Automata Theory
ECE 8429	Topics in Intelligent Systems
ECE 8460	VLSI Design
ECE 8471	Software Reliability
ECE 8476	Computer Communications Security
ECE 8479	Software Engineering Projects
ECE 8787	Communication Networks

RECOMMENDED ELECTIVES (RE)

Courses listed under CPE Core and the CPE Electives categories can be used to satisfy the RE requirement providing they were not used to meet either of the two previous requirements. The following list of courses show some of the more popular courses selected to meet this requirement. Courses not on this list may also be used, but require approval.

ECE 7725	Electronic Music Synthesis
ECE 8224	Reliability Theory and Practice
ECE 8240	Computational Algorithms
ECE 8464	VLSI Array Processors
ECE 8470	Introduction to Probabilistic Modeling and Analysis
ECE 8478	Pattern Recognition
CSC 8301	Data Structures and Algorithms
CSC 8410	Operating System Concepts
CSC 8470	Computer Graphics
CSC 8490	Database Systems and File Management
CSC 8505	Compiler Construction
CSC 8530	Distributed Systems
CSC 8540	Software Engineering
CSC 8560	Computer Networks

INDEPENDENT STUDY AND RESEARCH COURSES

ECE 9030	Independent Study
ECE 9031	Research I
ECE 9032	Research II
ECE 9940	Graduate Practicum

SPECIAL TOPICS AND PROJECT COURSES

ECE 9090	Electrical or Computer Engineering Project
ECE 9900	Special Topics in Electrical Engineering
ECE 9905	Supervised Study in Electrical and Computer Engineering

COURSES FOR LOCKHEED MARTIN COMPANY PROGRAM

The following two courses require permission of the Supervisor of Advanced Courses in Computers, Lockheed Martin Company, King of Prussia, PA. These courses count as recommended electives.

ECE 9910	Special Topics in Systems Engineering I
ECE 9920	Special Topics in Systems Engineering II

MASTER'S DEGREE THESIS OPTION

Before applying for the thesis option, students must first complete ECE 9030 as preparation. Application for the thesis option requires submission of a written research proposal outlining the plan of work for the Master's degree thesis and recommendation and approval of the student's research advisor. The chairman's approval is also required. Students who have qualified for the thesis option are required to make an oral presentation prior to graduation.

ECE GRADUATE CONCENTRATION CERTIFICATE PROGRAMS

The Electrical and Computer Engineering Department offers concentration certificates in

- **Communication Systems**
- **Computer Architectures**
- **Electric Energy Systems**
- **Electro-Mechanical Systems**
- **High Frequency Systems**
- **Intelligent Systems**
- **Wireless and Digital Communications**

A full description of each concentration certificate can be found in the Certificate section of this bulletin.

Admission requirements are the same, unless specified, as those for the graduate degree programs. Students will be required to meet all the course prerequisites and maintain a Grade Point Average of at least 3.00. Courses completed for the Certificate could be applied toward a Master's degree should the student wish to continue.

MECHANICAL ENGINEERING

Chair and Professor: *Nataraj

Professors: Ashrafiun, Ortega, Jones, *Santhanam

Associate Professors: Chun, **Fleischer, Jen, Kroos, Radhakrishnan, Karlsson

Assistant Professor: *Nersesov, *Ural, *Wu, Wemhoff, Feng, Clayton

Adjunct Professor: Sullivan

Adjunct Assistant Professor: Fouladi

Emeritus Professors: Marston, McAssey, Whitman

*Member Graduate Committee

**Chairperson Graduate Committee

PROGRAM OBJECTIVES

The Mechanical Engineering Department offers a graduate program of study leading to the degree of Master of Science in Mechanical Engineering (MSME). The program is a modern, relevant, well-rounded program that meets the needs of the full-time student as well as the working professional with a foundation in basic theory as well as modern engineering topics.

ADMISSION REQUIREMENTS

Ability to undertake graduate studies must be demonstrated by applicant's undergraduate record and letters of recommendation. In addition to the general requirements for admission described elsewhere in the catalog, applicant must hold an accredited bachelor's degree in mechanical engineering or its equivalent. Undergraduate course of study should have included, in addition to the usual two years of basic science and mathematics, at least one year of course work from the remaining two years in the area of solid mechanics, thermal sciences, dynamics, fluid mechanics, materials science and/or design. An applicant without an accredited bachelor's degree in mechanical engineering will be required to take additional undergraduate courses prior to formal admission. Students admitted to the MSME program are expected to be proficient in calculus and differential equations and capable of computer programming and working with advanced computing tools. Making up a deficiency may delay the completion of degree program.

DEGREE REQUIREMENTS

A minimum of thirty semester credit hours must be completed for the MSME Degree. All degree candidates are required to take ME 7000. Students must maintain at least a "B" average. A student will be dropped from the program if it is recognized by the graduate committee chairman that he/she will not be able to achieve a "B" average within the required thirty credits.

A maximum of six credits from outside the department may be accepted with prior approval of graduate committee chairman. The course(s) from outside the department must be closely related to the mechanical engineering field. A maximum of six credits may be transferred from other institutions and only courses with a "B" or better may be transferred.

PROGRAM DESCRIPTION

The program provides opportunity for students with varied backgrounds and interests to develop a study plan tailored to their needs. A student's program of study is planned in consultation with an advisor and is subject to the approval of Mechanical Engineering Department Graduate Chairperson. Additional details are provided in the MSME Policies and Procedures Manual, available online at www.villanova.edu/engineering/departments/mechanical/graduate/forms.htm.

A candidate for the degree of MSME may select courses which provide him/her with an exposure to several areas of mechanical engineering, or may select to specialize in one of the following areas: 1-solid mechanics, materials; 2-thermal sciences; 3-dynamics and control.

CERTIFICATE PROGRAMS

The Mechanical Engineering Department offers concentration certificates in

- **Electro-Mechanical Systems**
- **Machinery Dynamics**
- **Nonlinear Dynamics and Control**
- **Thermofluid Systems**

A full description of each certificate can be found in the Certificate section of this bulletin.

Admission requirements are the same, unless specified, as those for the graduate degree programs. Students will be required to meet all the course prerequisites and maintain a Grade Point Average of at least 3.00. Courses completed for the Certificate can be applied toward a Master's degree should the student wish to continue.

SUSTAINABLE ENGINEERING

COURSE DESCRIPTIONS

FACULTY