

NATIONAL TECHNOLOGICAL UNIVERSITY

Bulletin

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Information contained herein is subject to change without notice. For the most up-to-date information, please consult the online version of the bulletin located at www.ntu.edu/bulletin, and if there is any conflict, the content of the online bulletin supersedes the content of the printed version. Courses are not necessarily offered each term or each year. The university retains the exclusive right to judge academic proficiency and may decline to award any degree or certificate.

National Technological University (NTU) reserves the right at any time, without notice, to cancel any course or program listed in this bulletin or to change or modify any aspect of any course or program whenever, in its judgment, it becomes necessary or advisable to do so. Further, NTU disclaims all responsibility for failure to present or complete any course or program or to perform any other activity, function or obligation referred to in this bulletin if, for any reason, in its judgment the university cannot perform such activity, function or obligation.

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INTRODUCTION

The 2004–2005 academic year brings substantial improvement to NTU's academic systems and student services. As a result, this bulletin is substantially different than the 2003–2004 bulletin. A Web page (www.ntu.edu/transitions) has been created to explain these changes in more detail. Here are some of the highlights:

- **New academic infrastructure**—Substantial academic infrastructure has been added to support students and the curricula. New NTU positions have been created and filled, including academic directors, instructional associates, and an advising coordinator.
- **New Learning Management System (LMS)**—This is a new way of taking NTU courses. The system allows NTU to offer courses more frequently on a reliable schedule and provides a better way to ensure course quality. The most obvious indications of the LMS are the utilization of the eCollege course management system for all new courses and the presence of an instructional associate to support both students and faculty, ensuring a satisfactory learning experience. Eventually, all NTU course offerings will be converted to use the LMS.
- **Curricula**—Curricula revisions are planned that represent what NTU believes students actually want and need—based on past enrollments, Program of Study Plans, judgment of department faculty, and the implementation of the new academic model/Learning Management System.
- **Advising changes**—An advising coordinator, backed by the NTU academic staff mentioned above, assists students in negotiating these changes to help minimize the impact on their study programs.
- **New Web page and student information system**—A new Web page, accompanied by a new and streamlined student information system, is being planned for NTU and is likely to appear in early 2005.

If you have questions, comments, or suggestions, please email them to provost@ntu.edu.

National Technological University

Academic Calendar

NTU courses are delivered asynchronously online and/or using a variety of media within defined terms. NTU-originated courses run on a multiterm, multistart basis, up to six terms per year. Courses that originate from partner universities are scheduled based on the academic calendars of those universities. Please refer to the NTU Web site, www.ntu.edu, for information on the current academic calendar.

Master's Degree Programs

- Master of Business Administration (MBA)
- MS in Chemical Engineering*
- MS in Computer Engineering
- MS in Computer Science
- MS in Electrical Engineering
- MS in Engineering Management
- MS in Environmental Systems Management*
- MS in Manufacturing Systems Engineering
- MS in Materials Science and Engineering*
- MS in Mechanical Engineering
- MS in Microelectronics and Semiconductor Engineering
- MS in Software Engineering
- MS in Systems Engineering
- MS (Special Majors)

**No longer accepting applications for admission to this program*

Vision

Enabling working professionals to share premier educational resources globally via technology.

Mission

The National Technological University mission is to:

- Serve the advanced educational needs of graduate engineers, technical professionals and managers with relevant credit courses, master's degree programs and professional development.
- Award degrees at the master's level and credit-based graduate certificates.
- Explore, develop and use advanced educational and delivery technologies to deliver instructional programs to students at their employment locations or any place at which they elect to pursue their education.
- Provide excellent student support, advising and service.
- Provide an infrastructure linking technical professionals and managers nationally and internationally in research seminars, technology transfer activities and related technical exchanges.

Purpose

National Technological University shares with all universities these responsibilities: to enhance and extend knowledge, to transmit the intellectual content of the culture, and to educate people to think critically. As an institution dedicated to academic excellence and increased access to advanced education within an information society, NTU has the central purpose of enhancing national well-being by ensuring an appropriate supply of human resources to meet the technological and economic challenges of the future. In addition, as part of Laureate's (formerly Sylvan's) Online Higher Education division, NTU has adopted an international perspective, realized by extending the reach of NTU's programs to international sites across the globe.

NTU's educational programs, therefore, focus on engineering disciplines, information technology, management, and other fields deemed important to the development and maintenance of appropriate technology and management. The variety of academic offerings and experiences reflects the rapidly changing needs of a technological society, the aspirations of the students, the expertise of the participating faculty, the curricular requirements of the selected programs of study, and the results of research and development. Responsibility for achieving NTU's fundamental purpose rests with the community of scholars that constitute NTU. The university, in conjunction with its partner institutions and organizations, provides the services, environment, materials, and facilities necessary to

enable the faculty and students to discover, examine critically, disseminate, apply, and preserve the knowledge and wisdom essential to the enhancement of the quality of life for present and future generations. To these ends, NTU has identified and articulated four goals to provide a frame of reference for the university community.

Goals

1. Discovery of Knowledge

The university depends upon faculty drawn from accredited doctoral-level institutions to engage and prepare students for scholarly endeavors, creative activities, and basic and applied research. Because of its unique mission in an information, knowledge-intensive, technological society, the university encourages and fosters research and development of educational and delivery technology.

2. Dissemination of Knowledge

The university relies upon the most advanced pedagogical and technological methods to provide quality learning experiences for students at their work locations or wherever else they elect to take their courses. Students are expected to synthesize the delivered knowledge, think critically, communicate effectively, and use knowledge and technology intelligently and responsibly both to improve society and to participate creatively within society.

3. Application of Knowledge

The university accepts and acts upon the responsibility to serve the needs of an increasingly technological world. It is developing and applying both new and tested knowledge and technology to identified challenges. It is also providing the leadership required to implement educational innovation.

4. Preservation of Knowledge

The university recognizes and acts upon the responsibility to preserve and transmit the heritage of intellectual culture and knowledge to its students. It strives to develop the technology appropriate to those ends.

Objectives

In pursuit of its goals, the following objectives facilitate the university's planning and implementation processes. These objectives suggest the standards for evaluation of the university's programs and activities.

1. Learning

- To encourage and foster the development of innovative pedagogical and technological methods to enhance learning achievement.

- To offer relevant content from leading faculty to enhance the skills and knowledge of working engineers and technical professionals.

2. Student Support

- To provide excellent support services that enable students to be successful in their pursuit of educational goals.
- To select faculty with reputations for outstanding performance as teachers and scholars.

3. Organization and Administration

- To maintain a supportive organization and an administrative structure that rest firmly upon participatory management of academic programs.

4. Evaluation

- To continually evaluate programs and services to ensure continuous improvement and progress toward achieving institutional goals.

History

National Technological University was founded in 1984 as the first accredited "virtual" university. Lionel Baldwin, then dean of engineering at Colorado State University, foresaw how advanced technology could be used to offer engineering professionals the highest level of academic continuing education. With the support of major technology companies such as IBM, Motorola, and Hewlett-Packard, NTU was formed to deliver academic courses via a unique satellite network directly to corporations' training facilities. In 1984, NTU began offering degree programs using courses supplied by seven universities. Today NTU offers several master's degree programs with courses supplied through a consortium of U.S. universities. Courses are delivered online and via CD-ROM, DVD, and videotape.

In 2003, the Online Higher Education division of Sylvan Learning Systems, Inc., assumed control of NTU with a commitment to strengthen and expand the educational mission of National Technological University. In May 2004, Sylvan renewed its commitment to focusing solely on higher education and changed its name to Laureate Education, Inc. With the financial backing of Laureate Education, which provides a superior university experience to nearly 130,000 students through an international network of accredited online and campus-based universities, NTU is charting a new course of growth with a renewed determination to provide exceptional academic and professional development to working professionals.

Nondiscrimination Policy

National Technological University supports the provisions and the intent of the applicable state and federal statutes and regulations. Equal opportunity for employment and admission is extended to all qualified persons.

The university does not discriminate in admissions, program participation, or employment on the basis of race, age, color, religion, national origin, gender, sexual orientation, disability, veteran status, or other legally protected characterization. A student or university employee who believes they have been subject to any such discriminatory acts should report them to Provost, National Technological University, 155 Fifth Ave. S., Suite 600, Minneapolis, MN 55401; 612-312-1296.

Licensure

Colorado

National Technological University is an out-of-state accredited institution authorized to deliver courses and programs in Colorado. Inquiries concerning the standards or school compliance may be directed to the Colorado Commission on Higher Education at 1380 Lawrence St., Suite 1200, Denver, CO 80204.

Minnesota

National Technological University is licensed by the State of Minnesota. Inquiries concerning the standards or school compliance may be directed to the Minnesota Higher Education Services Office, 1450 Energy Park Dr., Suite 350, St. Paul, MN 55108.

Oregon

National Technological University is authorized by the State of Oregon to offer and confer the academic degrees described herein, following a determination that state academic standards will be satisfied under OAR 583-30. Inquiries concerning the standards or school compliance may be directed to the Oregon Office of Degree Authorization at 1500 Valley River Dr., #100, Eugene, OR 97401

Academic Organization

To conduct its academic functions, National Technological University uses the expertise of outstanding faculty from accredited doctoral-level higher learning institutions. These individuals are organized by program to form graduate faculty committees. The NTU chief academic officer appoints the chair of each program. Extensive use is made of the NTU annual meeting, electronic mail, computer conferences, and teleconferences

to carry out committee activities. An NTU academic director and the chair of each program establish the committees needed to ensure program quality.

Each curriculum is under continual evaluation. Courses are carefully reviewed by the appropriate curriculum committees before being recommended to the Academic Policy Advisory Committee and provost for inclusion in NTU's offerings.

Each matriculated student in an NTU degree program is assigned an academic advisor who may call on the general academic staff and consulting faculty from accredited doctoral-level universities to provide additional student advice. Advisors have access to student records through an interactive, computer-based record system maintained by NTU. Non-matriculated students may seek advice from the program chairs or the academic directors. Academic policies governing admissions, continuation, and graduation are set by the Academic Policy Advisory Committee and implemented by the NTU academic offices.

The Academic Policy Advisory Committee considers and makes recommendations on academic affairs to the provost/chief academic officer, president, and the NTU Board of Directors. The academic organization follows NCA accreditation criteria by providing participants in the NTU academic governance structure both the freedom and the responsibility to make specific recommendations regarding the development and maintenance of outstanding programs of study in advanced subjects of importance to engineers, technical professionals, and managers.

Board of Directors

National Technological University's Board of Directors includes industry representatives, alumni, members from partner universities, and members of the public at large. Individuals serving as directors are listed in the University Administration section of this bulletin. The board delegates authority to NTU administrators and governance committees to recommend academic policies and manage the university within the framework of approved policies and procedures. To communicate with the Board of Directors, send an email to provost@ntu.edu.

Delivery System and Facilities

NTU's corporate offices are located in Baltimore, Md.; its academic offices are located in Minneapolis, Minn.; and its information technology support operations are located in Los Angeles, Calif. Faculty may be located on the campuses of partner or nonpartner universities, and students are located at their work sites, homes, or other loca-

tions. Students receive instructional programs via the Internet, telecommunications equipment, and other computer technologies.

The mission of the NTU delivery strategy is to increase accessibility by utilizing multiple distance-learning technologies to enrich the learning experience and respond to the varying needs of students. NTU delivers its programs using a wide range of delivery systems, including the Internet, VHS videotape, CD-ROM, video CD, and DVD.

Many courses are offered online directly from partner universities. These courses may employ streaming video, audio-over-slide presentations, and other technologies as part of the course delivery. A number of universities provide lectures on CD-ROM. Videotapes are also available for many courses. Course formats are identified in the *Class Schedule* each term and online at www.ntu.edu.

Most students communicate with other students and instructors using electronic means such as email, threaded discussions, and chat rooms. Traditional methods of communication include telephone, fax, mail, and express mail. All students can participate and interact with students at other sites. Many NTU students make use of instructional services provided by sponsoring organizations, including classrooms, computers, laboratories, telecommunications and other equipment, and educational personnel. Finally, institutional and organizational libraries, combined with online and public/academic libraries in areas where students are located, provide learning materials.

University Partners

Many universities participate in the academic graduate programs offered by NTU: some institutions participate in many disciplines, while others provide courses only in selected subject areas. Many universities also produce the non-credit courses, tutorials, and research teleconferences offered by NTU. Finally, faculty from various institutions partner individually with NTU. The universities represented by NTU faculty include the following:

Arizona State University
Boston University
Columbia University in the City of New York
Florida Gulf Coast University
George Mason University
Georgia Institute of Technology
Georgia Southern University
Iowa State University
Kansas State University
Lehigh University
Massachusetts Institute of Technology

Michigan Technological University
New Jersey Institute of Technology
Northeastern University
North Carolina State University
Ohio State University
Oklahoma State University
Purdue University
Southern Methodist University
Stanford University
Stevens Institute of Technology
Washington and Lee University
University of Alabama in Huntsville, The
University of Arizona, The
University of Arkansas
University of California, Berkeley
University of California, Los Angeles
University of Central Florida
University of Colorado at Boulder
University of Delaware
University of Florida
University of Idaho
University of Iowa
University of Illinois at Urbana–Champaign
University of Massachusetts Amherst
University of Minnesota
University of Nebraska–Lincoln
University of New Mexico, The
University of South Carolina
University of Southern California
University of Tennessee, The
University of Texas, The
University of Texas at Austin, The
University of Virginia
University of Washington
University of Wisconsin

NTU contracts with these and other institutions and faculty to develop additional curricula and courses as demand warrants.

The *Class Schedule* for each term, which is on the NTU Web site (www.ntu.edu), contains additions or corrections to this bulletin as new courses are approved.

Accreditation

National Technological University is accredited by the Higher Learning Commission and is a member of the North Central Association, 30 N. LaSalle St., Suite 2400, Chicago, IL 60602; 312-263-0456.

Each partner university offering instruction in engineering subjects has undergraduate programs accredited by the Accreditation Board for Engineering and Technology (ABET) or its national equivalent. The specific programs for each participating school may be found in the current ABET annual report.

POLICIES AND PROCEDURES

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Admission

Questions about admission should be addressed to the NTU admissions specialist at 866-452-8732 or emailed to admissions@ntu.edu.

The latest information on admission policies and procedures, after the current bulletin has been published, will appear on the National Technological University Web site and in the online version of this bulletin at www.ntu.edu. Students are encouraged to access the Web for the most up-to-date information.

The NTU Board of Directors reserves the right to change admission requirements, policies, and procedures at any time, with appropriate notice.

NTU's admission decision reflects a judgment that an applicant has the background and potential to attain a master's degree from NTU, and thus the decision has taken into account the applicant's academic preparation and performance, relevant aptitude information, professional experience, and professional responsibilities. Because of NTU's unique mission to serve the needs of graduate engineers and technical professionals around the world, NTU does not set geographical or other kinds of quotas or goals. All qualified applicants are admitted to approved programs of study. NTU is an equal access/equal opportunity institution.

Recommended Application Time

Because only admitted students are assigned an advisor, NTU recommends students who plan to seek admission to an NTU master's degree program apply as early as possible but definitely before they have finished *six* NTU semester credit hours. Students who continue to take courses without being admitted and assigned an advisor risk that one or more of the courses they have taken may not be accepted in their Program of Study Plan, causing unnecessary expense, effort, and delay.

Using Credits for Multiple Programs

Courses used for one degree program cannot be applied or transferred to another degree program. Only one course with the same degree designation and two-digit course number descriptor can be counted for a degree program. For example, SE 510-A, SE 710-NJ, and SE 710-R are considered the same course, and only one can be counted

toward a degree. Courses taken for a degree program cannot be taken for a pass/fail grade.

Double Majors

Students cannot be admitted to more than one master's degree program at a time.

Application Deadline

Applications for admission can be processed any time throughout the year; however, a 60-day lead-time is recommended for students who want to be admitted before the start of a specific term. The admission application, all transcripts, and other required items should be submitted to the NTU Office of Admissions at least 60 days prior to the start of the term to ensure processing before the term begins. If the admissions process is not completed before the term begins, a qualified student may still register for courses during that term. Students will be notified in writing when the admission decision is made.

Incomplete applications will be closed two months after the initial application, and submitted documents will be destroyed after one year. Students who wish to continue with the application process more than two months after their initial application was received are required to reapply and pay another nonrefundable application fee of \$50.

Application Materials

Online Registration and Application

Continuing NTU students (students who have taken courses with NTU previously or have already created a student profile) can log into the NTU Web site to register for courses.

New NTU students (students who have never taken a course with NTU) need to create a student profile at www.ntu.edu. For questions about creating a student profile, registering, or applying for admission on the Web, please call 800-582-9976.

Application Fee

Applicants to a master's degree program must submit an application online at www.ntu.edu and pay a \$50 nonrefundable admission application fee. Payment may be made by check, money order, or credit card. Credit card payments can be made by calling 800-582-9976, option 4, or by going online at www.ntu.edu. NTU will not bill an employer for the fee. Receipts are available upon request.

Transcripts

Official transcripts (i.e., transcripts sent directly from the registrar at the institution attended to the NTU Office of Admissions) are required from every regionally accredited undergraduate and graduate institution attended by the applicant. The application for admission will not be processed until NTU receives all official transcripts. A *Transcript Request Form* is available on the NTU Web site. NTU keeps transcripts for only one year after the application has been processed.

Applicants may choose to provide unofficial transcripts to the Office of Admissions to seek an admissions decision that is contingent upon NTU's receipt of official documentation.

Applicants who attended foreign institutions are required to provide an English-translated, certified-as-official copy of their transcript and diploma. NTU reserves the right to request an official transcript evaluation from an NTU-approved transcript evaluation agency.

Graduate Coursework for Credit Transfer

Appropriate graduate credit for studies at other institutions will be granted, provided the transfer course is applicable to the desired admitted degree program and meets the additional requirements stated under the Transfer Credit Guidelines section in this bulletin. Students are required to submit transcripts from all graduate institutions previously attended for evaluation. Transcripts will be evaluated by the respective program chair, who will determine the amount of transfer credit that may be awarded.

A transfer course cannot be used for credit if the course was used to meet a previous degree requirement. If the chair determines that transfer courses are applicable to the desired NTU graduate degree program and the student is admitted into the program, the admitted student will be notified which courses can be transferred and will be asked to go online to petition to transfer the credit, as outlined in the Transfer Credit Procedures section of this bulletin. Once the transfer credits are official in the student's record, the student's program requirements will be adjusted.

Optional Items

Letters of recommendation, statements of purpose, resumes, and copies of publications are not required for admission unless listed in the program's requirements. All applicants are encouraged to submit any such information to strengthen their admission files and provide a clearer understanding of their academic and experiential background and objectives.

Supporting documentation can be emailed to admissions@ntu.edu or faxed to 877-297-3837. Official transcripts should be mailed to:

NTU Office of Admissions
1001 Fleet Street, 4th floor
Baltimore, MD 21202

Misrepresentation

Applicants who fail to indicate all prior academic work and/or intentionally misrepresent grade point averages or other details of their academic records on the NTU application form are subject to dismissal from the university. Students not in good standing with any institution previously attended, either academically or financially, will be required to clear their records before they will be admitted to an NTU master's degree program.

Admission Classifications

Students admitted to a master's degree program will be accorded either *regular* or *provisional* admission status.

Regular Admission Status

Students admitted with regular admission status are admitted without any restrictions.

Provisional Admission Status

Students admitted provisionally are required to meet certain stipulations before advancing to regular admission status. Conditions vary on a case-by-case basis but generally include completion of any or all of the following, as determined appropriate by the chair:

- Foundation courses.
- The first three graduate-level courses with a grade of B or better in each course.

A minimum 3.0 cumulative NTU G.P.A. must be maintained. Admitted students who have a cumulative G.P.A. below 3.0 will be placed on probation status. *Students who do not meet the specified conditions within two years will automatically be placed in non-degree status.*

Automatic Admission

NTU requires that all applicants have a bachelor's degree from a regionally accredited institution or the equivalent from a foreign institution. Applicants who meet the following program-specific criteria will automatically be admitted to the degree program with regular admission status. Please see the

Academic Programs section of this bulletin for additional information on degree programs.

Master of Business Administration (MBA)

- BS degree in technology, engineering or a related field; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- At least two years of managerial work experience.
- Letter of support from a supervisor indicating the organization's support of the planned educational program and addressing the likelihood of academic and career success.

MS in Chemical Engineering

NTU is currently not accepting admission applications to this program.

MS in Computer Engineering

- BS degree in computer engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Computer Science

- BS degree in computer science.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Electrical Engineering

- BS degree in electrical engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Engineering Management

- BS degree in engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- At least two years of engineering work experience.

MS in Environmental Systems Management

NTU is currently not accepting admission applications to this program.

MS in Manufacturing Systems Engineering

- BS degree in engineering from an ABET-accredited program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Materials Science and Engineering

NTU is currently not accepting admission applications to this program.

MS in Mechanical Engineering

- BS degree in mechanical engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Microelectronics and Semiconductor Engineering

- BS degree in electrical engineering, chemical engineering, or materials science and engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS in Software Engineering

- BS degree in computer science or computer engineering or a BS degree in an ABET-accredited engineering program with a minor in computing systems or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- Evidence of knowledge of the key topic materials relevant to the program.

MS in Systems Engineering

- BS degree in an engineering discipline from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

MS (Special Majors)

- BS degree in an appropriate science or engineering area or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 3.0 on a 4.0 scale.

Non-Automatic Admission

Applicants who do not meet the specific criteria for automatic admission may still be eligible for regular or provisional admission. Applicants are encouraged to submit a detailed outline of their relevant work experience, letters of recommendation, resumes, and other items that will strengthen their applications and provide a clearer understanding of their academic and experiential background and objectives. Applicants with a BS in engineering from an accredited institution in the United States (or equivalent from a foreign institution) and a cumulative G.P.A. of at least 2.5 on a 4.0 scale are encouraged to apply. Applicants with degrees in other appropriate fields (e.g., physics, chemistry, math) and a cumulative G.P.A. of at least 2.9 on a 4.0 scale are also encouraged to apply. Applicants may be asked to provide GRE scores, evidence of having passed the Fundamentals of Engineering (FE) exam, or evidence of registration as a professional engineer (P.E.) in certain cases.

Petitioning a Denial of Admission

Applicants denied admission may appeal the decision. All appeals must be set forth in writing and will be reviewed solely on the basis of the written appeal and appropriate supporting documentation, if applicable, with no right of a formal hearing at any level. The determination of the Office of the Provost is final.

Advancing from Provisional to Regular Admission Status

When students have satisfied the provisional terms, they should notify the NTU Office of Admissions at admissions@ntu.edu. After NTU has verified that the provisional terms have been met, students will be sent notice of their advancement to regular admission status. Students must meet provisional terms within two years of admission and maintain a minimum 3.0 cumulative G.P.A. in their NTU coursework. Students who do not meet these terms within the two-year limit will be placed in non-degree status and must reapply for degree admission.

Reapplying for Admission

Applicants who are denied admission; students who are placed in non-degree status for failure to properly complete the admission process, failure to meet the terms of provisional admission, failure to work out of academic probation within the prescribed period of time, or failure to take courses within a two-year period; and students who have withdrawn may reapply to a master's degree program. Applicants who reapply must pay a \$50 nonrefundable application fee and may have to supply official transcripts and other supporting documentation.

Student Advising

Each student admitted to an NTU master's degree program is assigned an academic advisor. The advisor seeks to maintain regular communication with advisees to help them plan their studies and resolve any problems related to their academic programs. The advisor may call on participating faculty experts to assist in providing academic advice. Non-admitted students may seek advice from the NTU admissions officer, the program chair, the registrar, or the academic director.

When applicable, students are encouraged to discuss with their site coordinators the services that are provided. Site coordinators are obligated to maintain environments that are conducive to studying and learning.

Prospective students who have questions about degree programs may contact the Office of Admissions at 866-452-8732. Pre-admission advising questions may be addressed to the chair of the master's degree program.

Transfer Credit

Transfer credit is graduate-level academic credit completed at a regionally accredited institution other than NTU. Credit earned at an NTU partner institution but not taken directly via NTU must be petitioned and approved as transfer credit to be included in the student's Program of Study Plan.

Guidelines

Students admitted to regular admission status may petition to transfer credit. All courses, including transfer courses, used for an NTU degree must be completed within seven years.

Credit will not be allowed for transfer under any circumstances if any of the following apply:

- The course was used to meet a previous degree requirement.
- The final grade for the course was lower than a B.
- The course was taken on a pass/no pass (P/NP) or on a satisfactory/unsatisfactory (S/U) basis.
- The course was not a graduate-level course.

Maximum Number of Credits That Can Be Transferred

From Partner Universities

There is no limit on the number of credits a student may transfer from partner universities to NTU provided at least 18 semester credit hours (or equivalent in quarter hours) are taken directly through NTU. Courses being transferred from NTU partner schools must be from the same location as the NTU partner school. For example, if the University of Nebraska–Lincoln is the NTU partner university, a course from the University of Nebraska–Omaha would not be eligible for the partner university credit transfer arrangement.

This policy applies to current partner universities and to former partner universities for courses taken when the associated university was an NTU partner university. The policy does not apply to courses taken at a former partner university after the termination of the partner agreement.

From Non-Partner Universities

NTU may accept up to six transfer credits from an accredited university that does not have a partner agreement with NTU.

Special Transfer Fee

Transfer courses taken after admission to an NTU degree program are subject to a special transfer fee of \$50 per course. The student will be billed the \$50 per course transfer fee at the time the transfer credit is approved.

Procedure

Students who want to transfer credit to NTU must submit the following to the NTU Office of the Registrar:

- A *Petition for Transfer of Credit*, via the Web.
- An official transcript showing the course(s) to be transferred.
- A photocopy of the catalog description of the course(s).
- A current Program of Study Plan via the Web.
- A copy of the syllabus for the course to be transferred (including a schedule of topics covered in the course).

If, at the time of a student's application to a degree program, the program chair determines that graduate courses completed prior to admission are applicable to the desired NTU graduate degree program and the student is admitted into the program, the admitted student will be notified which courses are eligible for transfer credit. The student will be asked to go online to petition to transfer the credit, using the procedures outlined above. Once the transfer credits are official in the student's record, the student's program requirements will be adjusted.

Students should contact their NTU advisor before submitting the *Petition for Transfer of Credit*. Acceptance of transfer courses as part of an NTU master's degree program will be approved by the student's advisor, NTU registrar, the appropriate program chair, and the academic director. Transferred courses will appear on the NTU transcript but will not be calculated into the NTU G.P.A. or the NTU earned-hours.

Course Registration

Questions about registration should be addressed to NTU at 800-582-9976.

Online Services

General Information

General information about NTU and its program offerings can be accessed through the NTU Web site at www.ntu.edu. Information available online includes course descriptions, master's degree curricula, application procedures, registration procedures, the current *Class Schedule* and bulletin, and contact information.

NTU Profile

Access to certain information and services (such as program application and course registration) requires students to log into the NTU Web site, which requires an NTU profile. Creating an NTU profile is a simple process that enables NTU to deliver secure Web services that fit students' specific needs. Information collected is used only by NTU and NTU partner universities and will not be sold by NTU to any third party for marketing purposes. To read NTU's privacy policy, choose "Legal Notices" from the NTU home page.

Students who have taken courses from NTU already have a profile. To retrieve lost login names and passwords, students can call 800-582-9976.

Online Registration

Students must have an NTU profile established before they can register for courses online.

The easiest way to register for courses is via the NTU Web site. Course descriptions can be accessed by conducting a keyword search or by browsing the full course listings. To access course listings, students should go to www.ntu.edu, choose the "Academic" tab and select from the options presented.

After selecting a course, students must choose either "Credit" or "Audit" and will be asked to supply proctor information. If the course is a variable-credit course, students will select the number of credits they would like to receive. Students will then be asked to select a delivery method from the options available for that course (e.g., CD-ROM, DVD, online, videotape). Finally,

students should read the authorization agreement and click "I Accept the Above Agreement" to complete the registration process. Payment information, including billing and shipping addresses, may be required: if so, on-screen instructions will prompt students to provide this information.

Registration Requirements

Individuals who plan to take courses as non-degree-seeking students do not need to apply for admission into an NTU degree program or pay the \$50 admission fee.

Credit Registration

An appropriate bachelor's degree from an accredited institution in the United States or the equivalent from a foreign institution is required. The degree must have been awarded prior to registration for any NTU course.

An appropriate degree is a degree that could reasonably be expected to provide the student with adequate quantitative and subject background to satisfactorily complete the NTU course(s) concerned. Students who have a bachelor's or advanced degree, but one that is not clearly related to engineering, computer science, or a physical science (i.e., math, chemistry, or physics) may be eligible if they have other documented background in preparation for the NTU course.

A minimum undergraduate G.P.A. of 2.5 on a 4.0 scale is required for registration for both degree- and non-degree-seeking students. (Applicants who fail to indicate all prior academic work or misrepresent their grade point averages or other details of their academic records are subject to dismissal from the university.)

Students are responsible for meeting the stated prerequisites for all courses for which they register.

In some special circumstances, partner universities might require additional information such as Test of English as a Foreign Language (TOEFL) scores or degree certifications.

Audit Registration

It is expected that auditors will have an adequate background to benefit from any course taken. Persons who register as auditors work on their own schedules and under their own direction. They do not interact with the instructor, have assignments evaluated, take examinations, have a course grade recorded, or receive credit for the course.

Individuals are prohibited from "sitting in" on a course unless they are officially registered for credit

or audit. Courses taken as audit may not be retroactively converted to credit.

Materials Required for Course Registration

a) Course Registration

Students can register for courses on the NTU Web site at www.ntu.edu.

b) Employer Requirements

Students are responsible for contacting their employers about any specific company requirements related to their education.

Applying for a Login Name and Password Online

To access secured services and information, students first need to create a profile by going to www.ntu.edu and following the instructions. New NTU students must create a profile before they can access the online registration and admission system. Existing students should already have a login name and password. Students who need help with their login name or password should contact profileproblems@ntu.edu.

Deadlines for Registration

The course registration process needs to be completed according to the registration deadlines posted on the NTU Web site. For NTU-originated courses, the registration deadline is the end of the third day of the class term; deadline dates vary among the partner universities. If registrations are not received in a timely manner, courses may be cancelled due to low enrollment. Students who attempt to register for courses originating from partner universities after the start of a course must receive permission from the instructor and administrative contact. Additionally, the student must submit full payment to the Office of the Bursar before the Office of the Registrar will officially register the student for the course.

Course Cancellations

Participating institutions may cancel a course due to low enrollment or other unforeseen circumstances; therefore, NTU reserves the right to cancel a scheduled course. A full refund will be given to all students who have registered for a course that is cancelled.

Changes of Registration Status

Dropping a Course

A student may drop a course prior to the end of the ninth week of class on the semester schedule or 9–14 week summer session, or prior to the end of the sixth week of class on the quarter schedule or 5–8 week summer session. When a student drops a

course, no entry appears for the course on the NTU academic transcript. For a student to be dropped from a course, the Office of the Registrar must receive an official request from the student. A *Change of Registration Status* form may be submitted online at www.ntu.edu (from the Community Login, students should select “Academic Programs” then “Forms and Requests” and “Change of Registration”). Students are advised to check their records on the Web site to ensure that NTU received the *Change of Registration Status* form. See the Tuition and Fees section of this bulletin for a refund schedule. No changes of registration status can be made beginning with the final week of class.

Drop refunds will be based on the university’s published on-campus start date rather than the actual NTU course start date.

Withdrawing from a Course

A student who formally requests withdrawal after the ninth week of class for semester courses or 9–14 week summer session courses (or after the sixth week for quarter courses or 5–8 week summer session courses) and before the final week of class, may receive a grade of *WP* (Withdraw Passing) or *WF* (Withdraw Failing) depending on instructor evaluation. Grades of *WP* and *WF* are not calculated in the student’s cumulative G.P.A. A request for withdrawal requires approval by the instructor who must indicate the date of withdrawal and a grade of *WP* or *WF*. The request must be submitted online at www.ntu.edu.

Discontinuing a Course

If a student quits attending a course, but fails to officially drop or withdraw by following the procedures above, a grade of *F* will be recorded on the official NTU transcript.

Changing from Credit to Audit or Audit to Credit

A student may change his or her registration from credit to audit until the end of the fourth week of class for semester courses or 9–14 week summer session courses, or until the end of the third week of class for quarter courses or 5–8 week summer session courses, and will be billed the audit fee.

Registration may be changed from audit to credit until the end of the third week of class for semester courses or 9–14 week summer session courses, or until the end of the second week of class for quarter courses or 5–8 week summer session courses, and will be billed the credit fee.

A *Change of Registration Status* form, available at www.ntu.edu, must be submitted to the Office of the Registrar for each of these changes.

Course Administration

Student Support

Many NTU students' employers provide facilities equipped to receive instruction delivered by NTU. Such corporations may also appoint site coordinators responsible for the interactions among the corporation, the students, and NTU. In some cases, corporations may provide tutors and other assistance. The site coordinator is responsible for the delivery of instruction at the site and for the resolution of all technical and communication problems; he or she is also responsible for proctoring exams. NTU recommends that students who are at such sites become fully acquainted with their site coordinator's role and responsibilities.

A student who does not have a site coordinator at his or her facility will be considered an "independent" student and should communicate directly with NTU. For the administration of exams, independent students are responsible for identifying a proctor who meets both NTU and partner university requirements.

Optimizing Instruction

Class viewing occurs in several forms. Some sites have classrooms where students meet on a regular viewing schedule, while others have individual viewing carrels where students view lectures at their convenience. Still others give students videotape copies of the lectures to take home. Whatever the viewing mode, it is important that site coordinators ensure that students have their lectures and accompanying notes and handouts on a regular and timely schedule. Delays put students behind in courses and may jeopardize their grades. Independent students will receive their media and any associated handouts at a location they designate. All students are responsible for adhering to the schedule and completing assignments and exams per the course syllabus or instructor directions.

Class Schedule

The *Class Schedule* is available on NTU's Web site at www.ntu.edu and contains the most up-to-date information on course content, prerequisites, textbooks, and instructors. A *Class Meeting Times and Shipping Schedules* document is posted on the NTU Web site prior to the start of each academic term.

Instructors

Questions about course content should be directed to the contacts specified on NTU's Web site. For NTU-originated courses, questions may be addressed to the academic director or to the instructional associate for the course.

Instructors for courses from partner universities are located on the campuses of those universities. Because individual schools and instructors have different ways of administering courses, students should contact instructors to understand how each course is conducted and to gain the maximum benefit from each class.

Course Requirements

Enrolled students are informed of course requirements at the beginning of the term. Each enrolled student is responsible for the fulfillment of those requirements in a timely manner. Late assignments will be accepted only with advance approval of the instructor or instructional associate. Examinations/quizzes required by instructors must be completed as scheduled. If stipulated by the instructor, exams will need to be administered by a designated site coordinator or, in the case of independent students, by a proctor.

Textbook Ordering

Total Information, Inc., is the text distribution agent for all NTU academic courses.

Total Information, Inc.
844 Dewey Avenue
Rochester, NY 14613 USA
www.totalinformation.com
orders@totalinformation.com
800-876-INFO (876-4636) or 585-254-0621
585-254-0209 Fax

Examinations

Examinations, when appropriate, are given during the term. Instructors may assign take-home examinations and term projects or papers in lieu of proctored examinations. The following procedures apply to proctored examinations:

- The site coordinator or proctor schedules the time, duration, and place of the examination based on the instructor's directions.
- The site coordinator or proctor ensures the integrity of examination procedures.

Media Guidelines, Copyright Issues, and Security

NTU sites are authorized to duplicate videotapes and CD-ROMs of lectures for that site's registered students. The content of these media remains the property of NTU and its providers. Media for academic courses may be retained up to two weeks after the last class lecture of the academic term. All media must be destroyed at that time. These policies must also be adhered to by independent students and by all other students who do not have designated site coordinators at their locations.

All sites and students must adhere to U.S. copyright laws in conjunction with their participation in the NTU academic program.

Copyright Obligations

NTU recognizes and respects intellectual property rights. As part of its mission to maintain the highest standards for ethical conduct, the university requires its employees, faculty, students, and other university community members to use copyrighted materials in a lawful manner.

No employee, faculty, student, nor other university community member may reproduce any copyrighted work in print, video, or electronic form in violation of the law. The easiest way to avoid violating the law is to obtain express written permission from the copyright holder. Copyright laws in the United States may protect works even if they are not registered with the U.S. Copyright Office and even if they do not carry the copyright symbol.

Copyrighted works include, but are not limited to, printed articles from publications, TV and radio programs, videotapes, musical performances, photographs, training materials, manuals, documentation, software programs, databases, World Wide Web pages, and CD-ROMs. In general, the laws that apply to printed materials also apply to visual and electronic media.

NTU directs its employees, faculty, students, and other university community members to obtain appropriate permission from copyright holders directly, or from their licensing representatives, when reproduction or duplication exceeds fair use. The fair use doctrine allows limited exemptions to copyright infringement liability when copyrighted works are used for purposes such as comment, criticism, teaching, scholarship, or research, particularly when the use of the work is limited in amount and scope and is for noncommercial purposes. To learn more about fair use, visit www.loc.gov/copyright/title17/92chap1.html.

Evaluations

At the end of each semester, NTU sends out an evaluation form via email to all enrolled students. The results are tabulated and reported by NTU. NTU uses the results to assess course/program quality and to acknowledge outstanding instructors. Outstanding instructors are listed on NTU's Web site.

Student Responsibilities

Students are responsible for working with their site coordinators in a timely manner when registering for credit courses, viewing courses, handing in assignments, and taking examinations. Independent students, and all other students who do not have designated site coordinators, are responsible for these course-related activities. Students may request an extension of course deadlines if travel, illness, or work demands cause delays in excess of two weeks. Any request for an extension must be made to the instructor prior to the deadline.

Students are responsible for

- familiarizing themselves with NTU's academic policies, guidelines, and deadlines;
- reading course descriptions to determine the applicability of a course to a particular degree;
- determining whether they meet the stated prerequisites for courses in which they register; and
- paying tuition in a timely manner.

Academic Integrity

NTU's reputation depends on maintaining the highest standards of intellectual honesty. Commitment to these standards is the responsibility of every student, site coordinator, proctor, and instructor involved with NTU.

NTU instructors, site coordinators, and proctors are expected to use reasonable means to prevent and detect breaches of academic integrity. Students are expected to exhibit honesty and competence in their academic work.

Instructors who are convinced that academic integrity is compromised or that a student's learning environment is unacceptable may deal with the suspected violation by discussing it with the student, site coordinator, proctor, or the NTU Office of Academic Programs. The instructor may also refer the matter to the appropriate person(s) at the university offering the course. If it is determined that a

violation has occurred, the instructor will determine how the violation affects the student's grade for the course. The academic regulations at that university apply.

A student who is dissatisfied with the instruction received or course interaction should first discuss the complaint with the site coordinator or proctor and the NTU academic director. If the issue is not resolved at that level, the student may contact the NTU Office of the Provost to request action. The Office of the Provost will make the final decision after consulting with the site coordinator or proctor, the academic director, the instructional associate (for NTU-originated courses), and the instructor.

Courses of Instruction

National Technological University reserves the right to change the listing of courses without notice.

As discussed in the Introduction to this bulletin, NTU is transitioning to a new Learning Management System and model of delivery. Thus, students will see significant changes to the way many courses are delivered. During this transition period, increasingly more courses will originate from NTU's eCollege platform. During the transition, certain courses will continue to be delivered by the partner university. Course information, including delivery options, will be listed at www.ntu.edu. New courses and programs are added periodically. The frequency of individual course offerings depends upon programmatic priorities, student demand, and program needs.

Note: The most up-to-date information about each course is available on the NTU Web site.

Terms of Instruction

NTU offers courses in accordance with the calendars of partner universities. Most institutions use the semester calendar, and a few use the quarter calendar. Moreover, some courses may be offered on special schedules that will be announced well in advance. Students must consult the NTU Web site.

Prerequisites

Permission of the instructor to enroll in a course is implied when the student meets the specified prerequisites. If there is any concern, the student should discuss the prerequisites with the instructor or with an advisor, academic director, or instructional associate. Academic prerequisites notwithstanding, enrollments are sometimes limited to a specified number of students, to students within a specified degree program, or to students at particular levels (i.e., entry or advanced).

Course Fees

Tuition is posted on each individual course Web page. Additional fees may apply. Tuition and fees do not include the cost of textbooks and other required learning materials.

Special Topics Courses

NTU special topics courses are independent study courses that may include extra credit for regular credit courses, special laboratories, and professional development program (PDP) courses. Special topics courses must be arranged with the agreement of the student's NTU academic advisor and program chair in advance of registration. Special topics course requirements will be determined by the student's NTU advisor in accordance with normal, acceptable university practices.

PDP courses may be taken for 0.1–0.5 semester credit hours; special labs, etc., may be taken for 1–3 semester credit hours. Tuition for special topics courses is based on the percent of semester credit hours of the current NTU rate, plus a \$100 per semester credit hour special fee (minimum 1 semester credit hour).

When a student takes a PDP course for credit, he or she enrolls in the PDP course in the usual way and also enrolls for the desired number of credits (maximum 0.5 semester credit hours) in the NTU credit program. The student needs to contact the NTU Office of the Registrar to obtain the appropriate course number for credit registration.

Special topics courses must be completed within one year. Students need to work with their advisors to complete a project to fulfill the special topics requirement.

Course Delivery

NTU offers courses via a variety of nontraditional delivery methods that are identified in each course description. When registering for courses, students need to choose a delivery method. Delivery methods fall into the following categories:

CD-ROM

Course material can be viewed on any Windows PC with a CD-ROM drive running Windows Media Player 7.2 or above.

DVD

Course material can be viewed on a television screen with any DVD player with U.S. region coding (U.S. Standard) or on a Windows PC or Mac with a DVD drive and DVD playback software, including Windows Media Player 7.2 or above.

DVD-R

Course material can be viewed on most Windows PCs and Macs with a DVD drive (indicating DVD-R compatibility) and Windows Media Player 7.2 or

above. Course material may also be viewed with a DVD player, depending on the model and date of manufacture.

Online

Course material is delivered via streaming video and can be viewed on a Windows PC running Windows Media Player 7.2 or above. Many online courses also include downloadable course materials. Video quality is based on the speed of the Internet connection. (Not recommended for speeds lower than 56 kilobytes/second.)

Video CD (VCD)

Course material can be viewed at full-screen resolution on any PC or Mac with a CD-ROM or DVD drive and Windows Media Player 7.2 or above. Course material can also be viewed with a DVD player, depending on the model and date of manufacture.

Videotape (VHS)

Course material can be viewed on any standard VHS tape deck and television capable of playing NTSC (U.S. Standard) video. The material is recorded at SP speed.

Course Numbering System

NTU course numbers are codes that indicate course-area designation, course level, sub-area and the offering institution. For example:

AD 711-R Algorithms and Data Structures

AD = Course Area (*Algorithms and Data Structures*)
7 = Course Level (*700 - Advanced Graduate Course*)
11 = Sub Area
R = Institution (*University of Florida*)

300 - Undergraduate Course
500 - Introductory Graduate Course
700 - Advanced Graduate Course

Institution Identification

The suffixes following course numbers identify the institution offering the individual course:

A University of Massachusetts Amherst
AH University of Alabama in Huntsville, The
AT University of Alabama, The
AR University of Arkansas
CA University of California, Berkeley
CL Columbia University in the City of New York
CU University of Colorado at Boulder
D University of South Carolina

DE	University of Delaware
E	University of Arizona, The
F	Northeastern University
FG	Florida Gulf Coast University
I	Michigan Technological University
KS	Kansas State University
LE	Lehigh University
N	Southern Methodist University
NB	University of Nebraska—Lincoln
NJ	New Jersey Institute of Technology
NM	University of New Mexico, The
NT	National Technological University
OB	Oklahoma State University, College of Business Administration
OE	Oklahoma State University, College of Engineering
Q	University of Illinois at Urbana—Champaign
R	University of Florida
S	University of Idaho
TN	University of Tennessee, The
U	Iowa State University
W	Arizona State University
Y	University of Washington

Course Area and Sub-Area Designations

The following is a list of all course area and sub-area designations and numbers within the NTU course numbering system. All course numbers start with a two-letter course area designation followed by a 3, 5, or 7 indicating the level of the course and a two-digit number indicating the sub-area. Foundation courses, which do not have a consistent two-letter course area designation, are listed at the end of this section.

AD—Algorithms and Data Structures

AD 10-19	Data Structures
AD 20-29	Design and Analysis of Algorithms
AD 30-39	Multiprocessor Algorithms (see also CA 50s, CM 50s, and CS 60s)

AE—Aerospace Engineering

AE 10-19	Analysis (see also MP 20s, ME 20s, and MS 60s)
AE 20-29	Mechanics of Compressible Fluids (see also ME 40s)
AE 30-39	Air Frame Design
AE 40-49	Structures
AE 90-99	Special Topics

CA—Computer Architecture

CA 10-19	Computer Architecture
CA 20-29	Parallel Systems and Interconnection Networks (see also CC 80s and ST 50s)
CA 30-39	Microprogramming

CA 40-49	Computer Descriptive Languages/High-Level Language Architecture
CA 50-59	Multiprocessor and Concurrent Computer Systems (see also CM 50s, CS 60s, and AD 30s)
CA 60-69	Microcomputers and Embedded Computer Systems
CA 70-79	Interfacing and Memory Systems
CA 80-89	Interactive Computer Systems
CA 90-99	Advanced Topics

CC—Communications

CC 10-19	Communications/Statistical Communications and Signal Theory (see also TC 10s, TC 20s, TC 50s, and CT 10s)
CC 20-29	Pattern Recognition and Remote Sensing
CC 30-39	Estimation and Detection Theory
CC 40-49	Information Theory and Coding
CC 50-59	Speech Processing
CC 60-69	Analog, Optical, and Digital Signal Processing (see also CR 50s)
CC 70-79	Image Processing and Radar Systems (see also IS 60s, EM 30s, and EM 60s)
CC 80-89	Telecommunications, LANs, and Communication Networks (see also TC 40s, ST 50s, and CA 20s)
CC 90-99	Advanced Topics

CH—Chemical Engineering

CH 10-19	Thermodynamics
CH 20-29	Transport Phenomena
CH 30-39	Chemical Kinetics, Catalysis, and Reactor Design
CH 40-49	Systems Analysis and Design
CH 50-59	Chemical Engineering Mathematics
CH 60-79	Chemical Engineering Electives

CM—Computational Methods and Theory

CM 10-19	Mathematical Logic and Automata Theory
CM 20-29	Formal Languages
CM 30-39	Computability and Computational Complexity
CM 40-49	Numerical Techniques (see also CT 60s)
CM 50-59	Methods for Parallel Computation (see also CA 50s, CS 60s, and AD 30s)
CM 60-69	Advanced Topics

CR—Circuit Theory

CR 10-19	General Circuit Theory
CR 20-29	Electronic Circuits (see also PS 40s)
CR 30-39	Non-Linear Circuits (see also CT 40s and PS 40s)
CR 40-49	Large Scale Systems—Analysis and Simulation (see also ST 30s, PS 50s, and PS 30s)
CR 50-59	Analog/Digital/Adaptive Filter Design (see also CC 60s)
CR 60-69	Switched Capacitor Filter Design
CR 70-79	Computational Methods and Graph Theory

CR 80-89	Optimization Techniques for Large-Scale Systems (see also PS 50s and PS 80s)	EM 50-59	Antennas
CR 90-99	Advanced Topics	EM 60-69	Applications (see also CC 70s)
<hr/>		EM 70-79	Scattering and Diffraction of Waves (see also MC 50s)
CS—Computer Software		EM 80-89	Computational Methods
CS 10-19	Methodology	EM 90-99	Advanced Topics
CS 20-29	Programming Languages	<hr/>	
CS 30-39	Translator Design Techniques	EP—Electrical Properties	
CS 40-49	Operating Systems	EP 10-19	General
CS 50-59	Database Systems	EP 20-29	Electronic Materials Processing (see also IC 30s and ES 10s)
CS 60-69	Distributed Computer Systems (see also CA 50s, CM 50s, and AD 30s)	EP 30-39	Device Fabrication and Packaging (see also IC 00s, IC 20s, and IC 30s)
CS 70-79	Multiprocessor Software Methods	EP 40-49	Physical Properties
CS 80-89	Modeling and Performance Evaluation	<hr/>	
CS 90-99	Advanced Topics	ES—Engineering Science	
<hr/>		ES 10-19	Physics (see also IC 60s)
CT—Control Theory		ES 20-29	Chemistry (see also PM 10s–40s and CH 10s)
CT 10-19	Linear Systems (see also CC 10s)	ES 30-39	Biology
CT 20-29	Feedback Control	ES 40-49	Geology
CT 30-39	Stochastic Control	ES 50-59	Health Sciences
CT 40-49	Nonlinear Systems (see also PS 40s and PS 70s)	ES 60-69	Nuclear Engineering/Science (see also EV 70s)
CT 60-69	Optimal Control (see also CM 40s)	ES 70-79	Civil Engineering/Science
CT 70-79	Digital Control (see also PS 40s and PS 70s)	ES 80-89	Environmental Engineering (see also EV 40s and 80s)
CT 80-89	Robotic Systems (see also IS 50s and PD 60s)	ES 90-99	Advanced Topics
CT 90-99	Applications of Control Theory	<hr/>	
<hr/>		EV—Environmental Systems Management	
DS—Digital Systems		EV 05-09	Environmental Systems Management
DS 10-19	VLSI Design Applications (see also IC 40s and 50s)	EV 10-14	Laws and Regulations
DS 20-29	Reliable Computation	EV 20-24	Risk Assessment
DS 30-39	Computer Arithmetic	EV 25-29	Fate and Transport
DS 40-49	High-Speed Computation	EV 40-45	Technology: Treatment
DS 50-59	Parallel Processing Hardware Systems	EV 50-59	Water Applications
DS 60-69	Digital Hardware Design (see also IC 80s)	EV 60-64	Air Applications
DS 70-79	Testing of Digital Hardware Systems	EV 65-69	Land Applications
DS 80-89	Fault Tolerant Systems	EV 75-79	Hazardous Waste
DS 90-99	Advanced Topics	EV 80-89	Science/Engineering
<hr/>		EV 90-94	Special Topics
EA—Emerging Areas		<hr/>	
EA 20-29	Multimedia	FT—Fast Track	
EA 40-49	Bioinformatics	FT 00-09	Fast Track—Computer Science
<hr/>		<hr/>	
EF—Economics and Finance		IC—Integrated Circuits	
EF 10-19	Managerial or Cost Accounting (see also MG 10s)	IC 00-09	Electronic Packaging (see also EP 20s)
EF 20-29	Financial Management (see also SP 40s and MG 40s)	IC 10-19	Electronic Materials (see also EP)
EF 30-39	Engineering Economics (see also MG 20s)	IC 20-29	Devices and Modeling (see also EP 30s)
EF 40-49	Managerial Economics	IC 30-39	Fabrication and Process Modeling (see also EP 20s, EP 30s, and MS 40s)
EF 50-59	Special Topics	IC 40-49	Circuit and System Design <i>including General VLSI</i> (see also DS 10s)
<hr/>		IC 50-59	VLSI Design Automation (see also DS 10s)
EM—Electromagnetics		IC 60-69	Physical Electronics (see also ES 10s)
EM 10-19	Lightwaves and Optics	IC 70-79	Analog Circuits <i>including Specialized VLSI</i> (see also EM 30s)
EM 20-29	Lasers and Quantum Electronics	IC 80-89	Digital Circuits <i>including Specialized VLSI</i> (see also DS 60s)
EM 30-39	Active and Passive Microwave Systems (see also CC 70s and IC 70s)	IC 90-99	Advanced Topics
EM 40-49	Field Theory		

IS—Intelligent Systems

- IS 10-19 General Methods for AI
- IS 20-29 Expert/Knowledge-Based Systems
- IS 30-39 Programming Languages for AI
- IS 40-49 Natural Language Processing
- IS 50-59 Intelligent Robotic Systems (see also CT 80s and PD 60s)
- IS 60-69 Computer Vision (see also CC 70s and PD 60s)
- IS 70-79 Machine Learning
- IS 80-89 Logic Programming and Deduction
- IS 90-99 Neural Networks

MA—Mathematics

- MA 10-19 Discrete Mathematics and Combinatorics
- MA 20-39 Probability and Statistics
- MA 40-49 Calculus/Complex Variables/Vector and Matrix Analysis
- MA 50-59 Queuing Theory and Statistical Analysis (see also TO 70s)
- MA 60-69 Algebra
- MA 70-79 Graph Theory and Topology
- MA 80-89 Differential Equations
- MA 90-99 Advanced Topics

MB—Management and Behavioral Science

- MB 10-19 Management for Engineers (see also TO 60s and MG 50s)
- MB 20-29 Organizational Behavior/Personnel (see also MG 60s)
- MB 30-39 Human Relations
- MB 40-49 Industrial Psychology
- MB 50-59 Law
- MB 60-69 Emerging Issues in Technical Management
- MB 80-89 Capstone Projects
- MB 90-99 Special Topics

MC—Materials Characterization

- MC 10-19 General
- MC 20-29 Surface and Interface Analysis
- MC 30-39 Characterization of Bulk Materials
- MC 40-49 Imaging and Image Processing (see also EM 10s and EM 70s)
- MC 50-59 Diffraction Techniques (see also EM 70s)
- MC 60-69 Non-Destructive Testing
- MC 90-99 Special Topics

ME—Mechanical Engineering

- ME 10-19 Mechanics, Dynamics, and Vibrations (see also MP 10s and MS 10s)
- ME 20-29 Design
- ME 30-39 Heat and Mass Transfer
- ME 40-49 Fluid Mechanics (see also AE 20s)
- ME 50-59 Combustion and Power-Producing Devices
- ME 60-69 Thermal Environmental Engineering
- ME 70-79 Thermodynamics (see also MS 20s)
- ME 80-89 Advanced Mechanics
- ME 90-99 Special Topics

MG—Business and Administration

- MG 10-19 Managerial Accounting
- MG 20-29 Global Marketing Management
- MG 30-39 Managerial Economics
- MG 40-49 Financial Management
- MG 50-59 Management of Technology
- MG 60-69 Organizational Behavior and Cultural Environments
- MG 70-79 Legal Environment of Business
- MG 80-89 Global Strategic Management

MP—Mechanical Properties

- MP 10-19 General (see also ME 10s)
- MP 20-29 Mechanics of Materials (see also ME 10s)
- MP 30-39 Deformation and Fracture Mechanisms
- MP 40-49 Multiphase Mechanics
- MP 50-59 Deformation Processing
- MP 60-69 Machining and Fabrication

MS—Materials Science

- MS 10-19 General (see also ME 10s)
- MS 20-29 Thermodynamics and Kinetics (see also ME 70s)
- MS 30-39 Materials Degradation
- MS 40-49 Solid State Chemistry (see also IC 30s)
- MS 50-59 Electronic, Atomic, and Molecular Arrangements
- MS 90-99 Special Project

NB—MBA Core Subject Areas

- NB 10-19 Management
- NB 20-29 Organizational Behavior
- NB 30-39 Marketing
- NB 40-49 Strategy
- NB 50-59 Accounting and Finance

PD—Product and Process Design

- PD 10-19 Design for Assembly
- PD 20-29 Design for Manufacturability
- PD 30-39 Facility Design and Material Handling
- PD 40-49 Manufacturing Processes (see also IC, MP, and SP)
- PD 50-59 Materials Processing (see also EP 20s and IC 30s)
- PD 60-69 Flexible Automation (see also IS 50s and CT 80s)
- PD 70-79 Integration of CAD/CAM/CAE (see also ST 10s)
- PD 80-89 Environmentally Conscious Manufacturing
- PD 90-99 Advanced Topics

PM—Polymeric Materials

- PM 10-19 General
- PM 20-29 Rheology
- PM 30-39 Processing of Polymers (see also MP 50s, MP 60s, and PD 40s)
- PM 40-49 Morphology and Molecular Structure

PS—Power Systems

- PS 10-19 Power Systems Analysis
- PS 20-29 High Voltage Engineering
- PS 30-39 Energy Conversion
- PS 40-49 Power Electronics (see also CR 20s, CR 30s, CT 40s, and CT 70s)
- PS 50-59 Operation of Power System/Stability & Control (see also CR 40s and CR 80s)
- PS 60-69 Energy Management Systems/Planning, Design, and Scheduling
- PS 70-79 Electric Drives (see also CT 40s and CT 70s)
- PS 80-89 Transmission Systems (see also CR 40s and CR 80s)
- PS 90-99 Advanced Topics

QM—Quantitative Methods

- QM 10-19 Operations Research (see also SP 20s)
- QM 20-29 Linear Programming (see also SP 20s)
- QM 30-39 Specialized Techniques
- QM 40-49 Decision Analysis
- QM 50-59 Systems Management or Engineering (see also MB 10s and TO 10s)

SE—Software Engineering

- SE 10-19 Software Engineering Methodology
- SE 20-29 Life Cycle Models and Software Metrics
- SE 30-39 Analysis and Design Techniques
- SE 40-49 Programming Environments and Implementation Issues
- SE 50-59 Testing and Reliability
- SE 60-69 Productivity Measures and Quality Assurance
- SE 70-79 Software Requirements and Specifications
- SE 80-89 Software Management, Psychology, and Control Methods
- SE 90-99 Advanced Topics

SP—Manufacturing Systems Planning and Control

- SP 10-19 Modeling and Analysis
- SP 20-29 Production Control and Scheduling (see also ST 30s, QM 10s, and QM 20s)
- SP 30-39 Materials Management and Logistics
- SP 40-49 Strategic Planning (see also TO 20s and EF)
- SP 50-59 Measurement and Sensing
- SP 60-69 Manufacturing Management and Integration
- SP 90-99 Advanced Topics

ST—Software Techniques

- ST 10-19 CAE/CAD/CAM Tool Development (see also PD 70s)
- ST 20-29 Real Time Software Systems
- ST 30-39 Simulation (see also CR 40s, SP 10s, and SP 20s)
- ST 40-49 Computer Graphics
- ST 50-59 Computer Networks (see also CC 80s and CA 20s)

- ST 60-69 Computer System Security
- ST 70-79 Internet Software Techniques
- ST 90-99 Special Topics

SY—Systems Engineering

- SY 10-19 Systems Engineering Principles and Processes
- SY 20-29 Systems Modeling and Analysis
- SY 30-39 Systems Concepts of Strategic Cost Analysis
- SY 40-49 Systems Optimization
- SY 50-59 Systems Reliability
- SY 60-69 Systems Management
- SY 70-79 Logistics from Acquisitions Systems Engineering
- SY 80-89 Systems Engineering Design

TC—Telecommunications

- TC 00-09 Telecommunication Principles (see CC 10s)
- TC 10-19 Telecommunication Technologies (see CC 80s)
- TC 20-29 Data Communications (see ST 50s)
- TC 40-49 Telecommunication Networks and Systems (see ST 50s, CC 80s)
- TC 50-59 Personal and Wireless Telecommunications
- TC 70-79 Telecommunication Systems Administration
- TC 80-89 Telecommunication Standards, Policy, and Regulations
- TC 90-99 Special Topics

TO—Technical Operations

- TO 10-19 Information Systems (see also QM 50s)
- TO 20-29 Forecasting (see also SP 20s and SP 40s)
- TO 30-39 Marketing Management/Industrial Marketing
- TO 40-49 Human Factors
- TO 50-59 Industrial Engineering
- TO 60-69 Project Management (see also MB 10s)
- TO 70-79 Quality Control and Reliability (see also MA 50s)
- TO 80-89 Production Management
- TO 90-99 Special Topics

Foundation—Computer Engineering, Computer Science, and Software Engineering

- AD 310-319 Data Structures (formerly BC 30-39 Data Structures)
- CA 310-319 Computer Architecture (formerly BC 60-69 Digital System Design—Computer Architecture)
- CA 360-369 Microcomputers and Embedded Computer Systems (formerly BC 40-49 Microprocessors and Assembly Level Programming)
- CM 310-319 Mathematical Logic and Automata Theory (formerly BC 80-89 Discrete Structures)
- CS 340-349 Operating Systems (formerly BC 50-59 Operating System Principles)
- DS 360-369 Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
- SE 330-339 Analysis and Design Techniques (formerly BC 10-19 Fundamentals of Computer Engineering)

Foundation—	Electrical Engineering
CC 310-319	Communications Systems (formerly BE 40-49 Systems)
CR 310-319	General Circuit Theory (formerly BE 10-19 Circuits)
DS 360-369	Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
EM 340-349	Electromagnetic Field Theory (formerly BE 30-39 Electromagnetics)
IC 320-329	Electronic Devices and Modeling (formerly BE 20-29 Electronics)
PS 330-339	Energy Conversion (formerly BE 50-59 Systems)

Foundation	
MA 320-339	Probability and Statistics (formerly BR 00-09 Mathematics)
MA 340-349	Calculus/Complex Variables/Vector and Matrix Analysis (formerly BR 00-09 Mathematics)
MA 360-369	Algebra (formerly BR 00-09 Mathematics)
MA 380-389	Differential Equations (formerly BR 00-09 Mathematics)
ME 310-319	Mechanics, Dynamics, and Vibrations (formerly BR 00-09 Mathematics)
MC 310-319	General Materials (formerly BR 40-49 Materials Science and Engineering and BR 50-59 Mechanical Engineering with the exception of BR 347-Q)
ME 325	Design (formerly BR 347-Q)

Academic Information

Credit-Award System

NTU awards credit on the basis of semester credit hours. Generally, a three-semester-credit-hour course is 14–15 weeks long and consists of 42–45 contact hours of instruction with additional time scheduled for final examinations. Quarter credit hours are converted to semester credit hours as follows:

Quarter Credit Hours	Equivalent in Semester Credit Hours
2	1.3
3	2
4	2.7
5	3.3
6	4

Maximum Credit Load

Normally, students may enroll for a maximum of 10 semester credit hours, or the equivalent in quarter hours, in any single academic term, quarter, or semester. Under certain circumstances, such as when employers permit students to study on a full-time basis, an exception to this policy may be made.

Grading System

NTU assigns the following quality points based on the instructor's allocation.

Grade	Quality Points
A	4.00
A-	3.75
B+	3.50
B	3.00
B-	2.75
C+	2.50
C	2.00
C-	1.75
D+	1.50
D	1.00
D-	0.75
F	0.00

The grade of A+ is not assigned. All recorded grades are included in the cumulative G.P.A. calculation.

Grade Notification

Grade rosters are available to the instructors on the Web prior to the end of the course. Instructors are required to submit student grades to NTU within 14 days of the course end date. Hard copies of grade reports are mailed by request only. Grade reports may be viewed on the NTU Web site in the student's academic profile.

Grades of *A/B* and *B/C* assigned by instructors of some universities are recorded on the student's NTU transcript as follows:

Grade Awarded by Instructor	NTU Transcript Notation	Quality Points
A/B	B+	3.5
B/C	C+	2.5

Grades of I: Incomplete

Instructors may, at their discretion, assign a grade of *I*. A grade of *I* is not automatic just because a course is not completed in time. Students who find that they are unable to complete a course within the allotted time must contact the instructor before the end of the term to request a grade of *I* and to work out the details for completion. *If a student fails to meet the terms stipulated within one year, the I grade is automatically changed to an F on the student's official NTU transcript.*

Grades of WP and WF

A student who formally requests (in writing) to withdraw after the ninth week of class and before the final week of class, will receive a grade of *WP* (Withdraw Passing) or *WF* (Withdraw Failing) depending on the instructor's evaluation.

A grade of *WP* or *WF* is not included in the calculation of a student's cumulative G.P.A.

Grades of W: Retroactive Withdrawal

A student may petition one term one time only—no exceptions—for retroactive withdrawal from a course or courses taken in a particular term. The petition must be in writing and will be reviewed solely on the basis of the written appeal, with no right of a formal hearing at any level. If the petition is approved by the NTU registrar, grades from one or more courses will be replaced with entries of *W* on the official NTU transcript. If the petition is denied, the existing grades will remain on the NTU transcript. A grade of *W* is not included in the computation of a student's G.P.A. nor are the corresponding units counted as units attempted. Petitions should be sent to the Office of the Registrar.

Note: For courses offered by partner universities, a retroactive withdrawal at NTU does not change the grade at the offering university. A grade change at the offering university must be petitioned directly to that university by the student.

Grade Point Averages (G.P.A.)

The *current* grade point average and *cumulative* grade point average are calculated by multiplying the quality points for each grade by the number of credits for that course, summing the results, and dividing the total sum by the total number of credits attempted during the term, or cumulatively, as appropriate.

All credit courses taken by students will appear on their NTU transcripts and will be figured into their overall G.P.A., with the exception of transfer courses. When a student retakes a course, to ensure that the new grade overrides the original grade, the student must contact the NTU Office of the Registrar. Any grade below a *C* (including a *C-*) cannot be used in the final Program of Study Plan.

Academic Standing

Good Academic Standing

Students admitted to NTU remain in good academic standing if their cumulative grade point average (G.P.A.) is equal to or greater than 3.0 on a 4.0 scale at the end of each term. A student failing to maintain good academic standing will be placed on probation and may be subject to dismissal from the university. To reestablish good academic standing, a student must bring his or her cumulative G.P.A. to 3.0.

Probation

Students are placed on probation if their cumulative G.P.A. falls below 3.0. Students placed on probation have two years to raise their G.P.A. to 3.0 or higher. At the end of two years, if at least a 3.0 G.P.A. is not attained, the student will automatically be placed in non-degree status. A student placed in non-degree status may reapply when his or her cumulative G.P.A. is 3.0 or above. The \$50 nonrefundable application fee must be paid again when the student reapplies.

Satisfactory Progress

Each student admitted to an NTU master's degree program is expected to maintain satisfactory academic progress, which will allow the student to graduate within the seven-year limit. (See the "Seven-Year Rule" policy in the Graduation section of this bulletin.)

Admitted students who do not take courses for

two consecutive years will automatically be placed in non-degree status. A student who wants to resume studies toward a master's degree will have to reapply and pay another \$50 application fee.

Equivalency Examinations

NTU has no provisions for equivalency examinations and does not give credit for "life experiences."

Repeating a Course

A student may repeat an NTU course only one time. When a student repeats a course, the student must notify the Office of the Registrar of his or her intent to replace the first grade with the second grade. A repeated course must have the same course number as the first course, but it does not need to be from the same school or be at the same level (e.g., SE 510-A may be replaced with SE 710-NJ or SE 710-R). Only the grade and hours earned for the second registration will count in the calculation of the student's cumulative G.P.A. Attempted hours and the grade for the first registration will be on the transcript but will not be calculated in the cumulative G.P.A.

Identifying Equivalent Courses

A degree program can include only one course with the same degree designation and two-digit course number. For example, students can include only one of the following in their Program of Study Plan: SE 510-A, SE 710-NJ and SE 710-R. It is important to note that equivalent courses share the degree prefix (e.g., "SE") and the same last two digits of the course number (e.g., "10").

Program of Study Plan (PSP)

Admitted students should submit a Program of Study Plan (PSP) to NTU upon completion of six semester credit hours. The PSP should be submitted to the student's advisor via the NTU Web site. Additionally, students must indicate on the PSP when they plan to take courses (by year and term), so NTU can schedule the courses.

Failure to submit a Program of Study Plan increases the possibility of students completing duplicate courses and courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSPs do guide NTU's course selection from partner universities. When course availability does not meet a student's needs, it may be necessary for that student to revise the approved PSP.

MS Thesis Guidelines

When desirable and appropriate, as determined by a student in consultation with his or her NTU advisor, a thesis option is available. NTU students who elect a thesis option should follow these guidelines:

- Obtain the agreement of an NTU advisor to use the thesis option. Choose and obtain agreement from a faculty member at an approved institution to act as the thesis advisor. Approval is given by the academic director, the program chair, and the student's advisor.
- Determine thesis requirements with the thesis advisor and academic director in accordance with normal, acceptable university practices.
- Conduct a thesis defense before an appropriate thesis-review committee, which will be arranged among the thesis advisor, the academic director and appropriate individuals, including industry experts.
- Ensure that appropriate library facilities are available.
- Enroll with NTU for six semester credit hours (course number assigned by NTU). Credit is earned upon completion of an acceptable thesis.

Tuition for thesis registration is charged at the current NTU tuition rate plus a special fee of \$100 per semester credit hour. Students who do not complete the thesis within one year must register and pay tuition and fees again.

Change of Major

Admitted students who want to change to a different major must submit an *Application for Change of Graduate Major* to the Office of Admissions. Students are admitted to only one NTU master's degree program at a time. Upon request for a change of major, transcripts may be requested again, and there will be a \$25 fee. For more information, call 800-582-9976.

Applications will be reviewed under the guidelines for automatic and non-automatic admission (see the Admission section of this bulletin). Applicants will be informed of the admission decision in a timely manner to facilitate course registration.

Student Records

The Office of the Registrar maintains all official student records, including academic transcripts and other pertinent information. Address changes and other modifications must be submitted in writing to

the Office of the Registrar or submitted online. NTU protects the privacy of student records in accordance with state and national statutes and regulations, which include the provisions of the Family Educational Rights and Privacy Act (FERPA) of 1974 (Buckley Amendment) regarding access to and disclosure of student information and records.

Transcripts

A student may obtain an NTU transcript by submitting a *Transcript Request Form* to the Office of the Registrar or by requesting it online. There is no charge for this service. NTU reserves the right to withhold a transcript under certain conditions, including, but not limited to, situations where a student is on financial hold because money is owed to the university.

Appeals

Except as specifically set forth in various sections of this bulletin or in occasional updates on the NTU Web site, decisions affecting students' status and academic standing may not be appealed.

Tuition and Fees

The National Technological University Board of Directors has the authority to set tuition and fees. The rates that apply during any succeeding academic year may not be known until March or April of the current year. The Board of Directors reserves the right to change the rates at any time deemed necessary.

Tuition and Fees

Course tuition per semester hour is listed with each individual course description. Costs are listed for both credit and for audit. For tuition rates and fees, go to www.ntu.edu and select the applicable course. Fees may cover videos, CDs, DVDs, and instructor notes. Fees vary depending on the originating source.

Special Fees

Course tuition and fee rates do not include the nonrefundable application fee that must accompany an application for admission to an NTU master's degree program or any charges for textbooks, other instructional materials, or computer support services. Below is a list of special fees that NTU may charge students who are applying for admission and those who are already admitted. These fees do not apply to "non-degree" students.

Schedule of Special Fees

Nonrefundable Application Fee:	\$50
Change of Major Fee:	\$25
Transfer Course Fee:	\$50 per course*

**Applies to transfer courses taken after admission into an NTU degree program.*

Special Topics Fees

Special topics courses are independent study courses that must be arranged with the agreement of the student's NTU academic advisor and program chair in advance of registration. These topics include the MS thesis; project courses, such as individual study and capstone courses; special topics courses as determined by the advisor and chair; and laboratory courses. *Please note that fees assessed for the special topics courses are in addition to the applicable tuition rate per semester credit hour.*

Schedule of Special Topics Fees

MS Thesis:	\$100 per semester credit hour
Project Courses (e.g., individual study and capstone courses):	\$100 per semester credit hour
Special Topics Courses:	\$100 per semester credit hour
Laboratory Courses:	\$100 per semester credit hour

Textbooks and Supporting Materials

Each student who registers for an NTU course must purchase textbooks and supporting materials. These additional materials are identified by course on the Web and in the *Class Schedule*. Textbooks and additional materials are nonrefundable and cannot be returned to NTU.

Payments

A registered student, or in some cases a sponsoring organization, is liable for the payment of tuition, fees, and all other charges. Each sponsoring organization sets its policy concerning the responsibility and method of payment for its sites. NTU students have several options for paying for courses. NTU realizes that financial situations and tuition reimbursement programs differ from one student to another and from one company to another; therefore, students are given maximum flexibility to pay for their courses.

- Prepay.
- Pay by credit card via the NTU Web site (charged to credit card 15 days prior to the university's published on-campus start date).
- Pay by check (must be received 15 days prior to the university's published on-campus start date).
- Approved alternative loan (must be approved through NTU's Office of Financial Aid).

Three Credit Card Payments

Students who choose to pay by credit card may elect to pay in three installments, as outlined below:

1st Payment:

$\frac{1}{3}$ due 15 days prior to the university's published on-campus start date, plus an administrative fee.*

2nd Payment:

$\frac{1}{3}$ due 25 days after the first payment.

3rd Payment:

$\frac{1}{3}$ due 60 days after the first payment.

* An additional \$55 administrative fee is added to the first amount due.

Note: Credit card numbers are kept on file confidentially and are automatically charged according to the option selected.

Company Pays

If a company currently pays NTU directly for student tuition, the company will be invoiced under the agreed-upon terms.

Company Voucher

If a company uses a tuition voucher program approved by NTU, students submit the voucher number to NTU prior to the university's published on-campus start date.

Note: A copy of the voucher must be sent to the Office of the Bursar for appropriate billing.

Refunds

Students who drop a course or change from credit to audit may be eligible for a partial tuition refund. The NTU Office of the Registrar must be informed of a request to drop a course or change registration status. (*Change of Registration Status* forms are available on the NTU Web site and from site coordinators.)

Within a specified time period (see the Course Registration section of this bulletin), students may change their registration status from credit to audit and be billed the audit fee. Students may also change their status from audit to credit and be billed the credit fee.

Refund Policy

NTU refunds tuition and fees according to the following policies and in accordance with applicable statutes and regulations. The amount of refund, if any, is dictated by the length of time a student has spent in academic attendance before cancelling enrollment or withdrawing from a course and the effective withdrawal/cancellation date (as confirmed by the Office of the Registrar) in relation to the most recent quarter or semester of enrollment for which the student has paid, as follows:

Each student will be notified in writing by letter or email of acceptance or rejection from enrollment in a specific course from the university. If a student is not accepted for enrollment, any tuition, fees, or other charges paid to NTU will be refunded in full. Acceptance for the purpose of enrolling in a specific course does not mean that a student is accepted into a program. The criteria of the specific program must be satisfied as well.

1. *For semester/quarter courses:* If a student provides written notice of cancellation or withdrawal to the Office of the Registrar within fourteen (14) days after being accepted for enrollment, then the student will receive a complete refund of all tuition, fees, and other charges paid to NTU, even if the program has already started.

For 14-week courses: If a student provides written notice of cancellation or withdrawal to the Office of the Registrar within twelve (12) days after being accepted for enrollment, then the student will receive a complete refund of all tuition, fees, and other charges paid to NTU, even if the program has already started.

2. *For semester/quarter courses:* If a student provides written notice of cancellation or withdrawal to the Office of the Registrar within fourteen (14) days after a course has started, then the student will receive a complete refund of all tuition, fees, and other charges paid to NTU for that course.

For 14-week courses: If a student provides written notice of cancellation or withdrawal to the Office of the Registrar within twelve (12) days after a course has started, then the student will receive a complete refund of all tuition, fees, and other charges paid to NTU for that course.

3. *For semester/quarter courses:* If a student provides written notice of cancellation or withdrawal more than fourteen (14) days after the start of the first class of a course, but before completion of seventy-five percent (75%) of the course (84 days after the start of the class), then the student will be assessed a portion of tuition, fees, and other charges paid to NTU for that course, and will receive a refund according to the following schedule for a standard semester/quarter (16-week) course:

Number of Days After Class Starts	% Tuition Refund
0-14	100%
15-25	91%
26-50	77%
51-84	55%
85+	0%

4. *For 14-week courses:* If a student provides written notice of cancellation or withdrawal more than twelve (12) days after the start of the first class of a course, but before completion of seventy-five percent (75%) of the course (73 days after the start of the class), then the student will be assessed a portion of tuition, fees, and other charges paid to NTU for that course, and will

receive a refund according to the following schedule for a standard 14-week course:

Number of Days After Class Starts	% Tuition Refund
0-12	100%
13-22	91%
23-46	77%
47-73	55%
74+	0%

5. Notices of cancellation or withdrawal from the university or from a university course are considered dated upon the postmark date if the notice is mailed by the student, or, alternatively, upon delivery date if such notice is hand-delivered or emailed to the Office of the Registrar.
6. Any notice of cancellation or withdrawal will be acknowledged within fourteen (14) days of receipt by the Office of the Registrar. Any refunds owed will be sent to the student through the university's accounting department within thirty (30) days of receipt of such a notice.
7. A student's refund is not linked to the university's student conduct policies.
8. No promissory instrument will be entered into with a student by the university prior to the student's completion of fifty percent (50%) of the applicable university course in which the student is enrolled.

Charges for textbooks and supporting materials are not refundable at any time after registration. Such materials cannot be returned to NTU. Additionally, any fees assessed by partner universities (such as instructional support materials and computer support services) will not be refunded by NTU.

Tax Deduction

Tax regulations permit an income-tax deduction for educational expenses undertaken to maintain or improve skills required for employment or to meet the expressed requirements of an employer or law imposed as a condition for retention of employment, job status, or rate of compensation. Individuals are advised to consult with their tax advisors and sponsoring organizations to ascertain the applicability of these regulations to their particular circumstances.

Graduation

Bulletin Under Which Students May Graduate

Candidates for master's degrees may elect to fulfill their degree requirements from the bulletin that was in effect at the time of their first enrollment after admission or from any subsequent bulletin.

Application for Graduation

Candidates must complete an application for graduation with their final Program of Study Plan and submit both to their graduation coordinator the term prior to completing degree requirements. Both forms are available at the NTU Web site at www.ntu.edu. Approval of the final Program of Study Plan and application for graduation takes four to six weeks.

Graduation Requirements

To be eligible for graduation, all of the following requirements must be met:

- The student must have earned a cumulative G.P.A. of at least 3.0 on all graduate-level work completed at NTU. (Undergraduate-level Foundation courses are not included in this calculation.) Grades below C (2.0 quality points) may not be used in the final Program of Study Plan.
- Final grades in all courses on the final Program of Study Plan have been recorded and reviewed to ensure that all degree requirements have been met.
- The appropriate academic advisor, curriculum committee chair, NTU registrar, and academic director have certified that the student has fulfilled all degree requirements.
- The NTU Board of Directors has officially approved the conferral of the degree(s).
- All outstanding invoices have been paid.
- Students who want to transfer credits have received approval of transfer courses from the program chair and have petitioned for the transfer credit, as outlined in the Transfer Credit section of this bulletin.

Graduation Ceremony

NTU has two graduation dates each year, with diplomas issued in February and June. The annual graduation ceremony is held in June. Students from both graduation dates are encouraged to participate in the annual ceremony.

Seven-Year Rule

NTU courses taken to satisfy degree requirements must be successfully completed within seven years. This time frame also applies to transfer credits. For specific information about transfer credit, see the Transfer Credit section of this bulletin.

Appeals concerning the seven-year rule must be made in writing and will be reviewed solely on the basis of the written appeal, with no right to a formal hearing at any level. The determination of the NTU Office of Academic Programs is final.

ACADEMIC PROGRAMS

National Technological University offers master's degrees in many selected disciplines and a Special Majors program. Each degree program is governed by a faculty committee. NTU senior staff in the central administrative office assist in coordinating all functions. The NTU Office of the Registrar responds to all requests for information about the various degree programs and ensures prompt communication with the appropriate faculty committees. The Academic Policy Advisory Committee of NTU is the highest faculty governing agency that recommends academic policy to the president and Board of Directors. For specific admission requirements for each degree program, see the Admission section.

Note: NTU and its partner universities reserve the right to alter the curriculum or the courses and any of the policies stated in this bulletin. The faculty members teaching the courses determine the course content, as reviewed and approved under the established procedures of their institutions. However, the curriculum committees of the various graduate faculties of NTU determine the appropriateness of the courses for fulfilling the degree requirements established by NTU.

- 32 Master of Business Administration
- 36 MS in Chemical Engineering
- 37 MS in Computer Engineering
- 40 MS in Computer Science
- 42 MS in Electrical Engineering
- 46 MS in Engineering Management
- 48 MS in Environmental Systems Management
- 50 MS in Manufacturing Systems Engineering
- 52 MS in Materials Science and Engineering
- 54 MS in Mechanical Engineering
- 56 MS in Microelectronics and Semiconductor Engineering
- 58 MS in Software Engineering
- 61 MS in Systems Engineering
- 63 MS (Special Majors)
- 65 Undergraduate Foundation Courses
- 67 Certificate Programs

Master of Business Administration

The Master of Business Administration (MBA) program is designed to provide engineers and technical managers an academic learning experience that qualifies them to be leaders, to better accomplish their managerial responsibilities and in many cases to advance in their management responsibilities. The curriculum is challenging and prepares students for management or leadership positions in all types of technical businesses and service and governmental organizations.

The MBA is a professional degree that provides knowledge relating to business management skills in diverse areas ranging from accounting to organizational behavior. It provides students the opportunity to learn the analytical, technical, and behavioral tools that can be used to solve organizational problems. Courses provide students an in-depth understanding of the business environment, including the importance of communication, consideration of ethics, awareness of stakeholders, management of change, and strategies for decision-making in complex situations.

Any person who has managerial experience can benefit from the formal study of business skills and knowledge that the MBA program provides. Students come from diverse backgrounds and include managers with undergraduate degrees in engineering, technology, computer science, and other technical and quantitative disciplines. NTU's MBA program is intended to meet the needs of this broad but unique population of working adult managers and supervisors who can benefit from a graduate business education. It is designed on the model of executive MBA programs, where students' busy schedules and work experience are acknowledged as qualifying them for a "fast track" program, allowing completion in approximately two-and-a-half years of part-time study.

The MBA program requires a minimum of 36 semester credit hours, consisting of core courses, specialization courses, and elective courses. The core courses have been developed based on extensive research into many leading MBA programs and comments from our corporate clients about what is lacking in these programs for engineers and technology professionals. The core courses also take into account the needs and skill sets that engineers and technical professionals

already possess. The core content has been developed in a collaborative, integrated manner to provide a coherent, consistent curriculum with various threads that students can follow to further develop their skill sets. These threads include the following:

- Change Management
- Communication and Collaboration
- Constituency Awareness
- Decision Making
- Ethics
- Managing Distance
- Networking

Elective courses may be taken from many of the diverse course offerings available through NTU. In many cases, students may choose to enhance their technical competency by taking coursework in one or more of the outstanding engineering graduate courses offered through NTU. Students should work with their NTU advisors to select the coursework most appropriate for their plan of study.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Master of Business Administration program:

- BS degree in technology, engineering, or a related field; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- At least two years of managerial work experience.
- A letter of support from a supervisor indicating the organization's support of the planned educational program and addressing the likelihood of academic and career success.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

A total of 36 semester credit hours are required for graduation. Students will complete six core courses, four courses within a specialization, and two electives chosen from any of the graduate-level courses offered through NTU.

Core Curriculum (18 credits)

There are six integrated and required core courses covering the following content areas:

- Organizational Behavior
- Leadership and Teamwork
- Strategy and Negotiation
- Technology and Operations Management
- Marketing Management
- Finance and Accounting

Due to the integrated design of the core with the inclusion of threads to further develop critical skill sets, the above core courses must be taken through NTU; students may not transfer credits for core content from other institutions. Students are encouraged to complete the MBA core courses prior to pursuing their specializations.

Specializations and Electives (18 credits)

Beyond the core MBA curriculum, students pursue specializations, completing four courses identified by NTU as appropriate to provide specialization in a particular area. That specialization may be enhanced further by choosing two associated elective courses. In each of the specialization areas listed below, NTU recommends elective content areas for further study; however, students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge. The MBA specialization areas include the following:

Creation and Distribution provides students the opportunity to emphasize manufacturing and logistics management in high-technology companies. Specialization courses include the following content areas:

- Total Quality Management
- Supply Chain Management
- Modern Manufacturing Method and Systems
- Operations Research

Suggested electives include the following:

- Integrated Design and Manufacturing
- Legal and Policy Issues
- Economic Decision Analysis
- Modeling Manufacturing Systems
- Risk Management
- Methods for Quality Improvement

Cross-Functional Projects, designed for engineers, computer professionals, and technical

managers, provides students with a systems view of project management. Specialization courses include the following content:

- Introduction to Project Management
- Advanced Project Management
- Project Planning, Scheduling, and Control
- Integrated Risk Management

Suggested electives include the following:

- Supply Chain Management
- Legal and Policy Issues
- Total Quality Management
- Methods for Quality Improvement
- Emerging Technologies
- Economic Decision Analysis

Emerging Technologies provides students the opportunity to emphasize strategic management and utilization of technology. Specialization courses include the following content areas:

- Emerging Technologies
- Marketing Advanced Technologies
- Global Competitive Environment
- Legal and Policy Issues

Suggested electives include the following:

- Supply Chain Management
- Project Management
- Advanced Project Management
- Integrated Risk Analysis
- Total Quality Management
- Methods for Quality Improvement

Information Strategies provides students the opportunity to emphasize the information systems or information technology sector. Specialization courses include the following content areas:

- Data Management
- Management of Computer and Information Systems
- Enterprise Resource
- Business Process Innovation

Suggested electives include the following:

- Information Systems
- Information Systems Principles

- Software Engineering
- Distributed Database Design
- Information Systems Security
- Datamining
- Legal and Policy Issues

Quantitative Studies provides students the opportunity to emphasize technical management, focusing on quantitative modeling and analysis to support engineering decisions and functions. Specialization courses include the following content areas:

- Operations Research
- Integrated Risk Management
- Total Quality Management
- Project Management

Suggested electives include the following:

- Supply Chain Management
- Global Competitive Environment
- Legal and Policy Issues
- Emerging Technologies
- Marketing Advanced Technologies
- Methods for Quality Improvements

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

Listed below are the MBA core courses and recommended course options for the specialization areas. The electives listed below are suggestions only: students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

Specific courses and course requirements may change. Updates will be posted on the NTU Web site.

Core Courses (18 credits)

- NB 720 Organizational Behavior—Working Within the Equations of State (first course for all admitted MBA students)
- NB 721 Leadership and Teamwork—Momentum Transfer Using Power, Influence, and Collaboration
- NB 740 Strategy and Negotiation—Solving the Boundary Value Problem
- NB 710 Technology and Operations—Moore's Law and Other Business Accelerators
- NB 730 Marketing—Maximizing the Organizational I/O Bus
- NB 750 Accounting and Finance—Measurement and Flow Control for the Economic Engine

Specialization and Elective Courses (18 credits) Creation and Distribution

Specialization Courses (12 credits)

- TO 750 Total Quality Management
- MG 723 Supply Chain Management
- SP 565 Modern Manufacturing Systems and Practices
- QM 710 Operations Research

Suggested Elective Courses (6 credits)

- TO 751 Methods for Quality Improvement
- TO 760 Introduction to Project Management

Cross-Functional Projects

Specialization Courses (12 credits)

- SY 563 Integrated Risk Management
- TO 760 Introduction to Project Management
- TO 761 Advanced Topics in Project Management
- NB 762 Project Planning, Scheduling, and Control

Suggested Elective Courses (6 credits)

- EF 735 Economic Decision Analysis
- MG 723 Supply Chain Management

Emerging Technologies

Specialization Courses (12 credits)

- TO 735 Marketing Advanced Technologies
- MG 726 Global Competitive Environment
- MG 770 Legal Environment of Business
- MB 713 Technological Innovation, Emerging Technologies, and Commercialization

Suggested Elective Courses (6 credits)

- SY 563 Integrated Risk Management
- MG 723 Supply Chain Management
- Information Strategies

Specialization Courses (12 credits)

- CS 750 Data Management
- SE 787 Management of Computer and Information Systems

SE 786 Business Process Innovation
NB720 Enterprise Resource Planning and Management

Suggested Elective Courses (6 credits)
TO 710 Information Systems
ST 760 Information Systems Security

Quantitative Studies

Specialization Courses (12 credits)
SY 563 Integrated Risk Management
TO 750 Total Quality Management
TO 760 Introduction to Project Management
QM 710 Operations Research

Suggested Elective Courses (6 credits)
TO 751 Methods for Quality Improvement
NB 750 Technological Innovation, Emerging Technologies,
and Commercialization

MS in Chemical Engineering

NTU is currently not accepting applications to this program. The following information is intended for students admitted to the program prior to September 2003.

The Master of Science degree program in Chemical Engineering prepares graduates to succeed in a wide spectrum of careers. Chemical engineers are equipped to contribute in all technical areas that involve the conversion of raw materials, through chemical or physical changes, to produce products of greater benefit to society.

Examples of important technical challenges where Chemical Engineering graduates will apply expertise include the areas of energy, global food supply, environment, medicine, and advanced materials. Meeting each of these challenges requires the intelligent application of the combined principles of chemistry and engineering exactly what chemical engineers are equipped to do.

The program requires a minimum of 33 semester credits (or the equivalent quarter credits) as approved by the student's academic advisor. These courses are distributed between two broad categories: core and elective. The core course requirements ensure a sound foundation in important chemical engineering fundamentals, and the elective courses provide an excellent opportunity to customize the curriculum to meet individual interests.

Most NTU students, many of whom maintain full-time jobs, can fulfill the degree requirements within six years by completing at least two courses each academic year.

Admissions Requirements

NTU is currently not accepting applications to this program. The following information is intended for students admitted prior to September 2003.

Applicants who do not possess BS degrees in chemical engineering will have to complete Foundation courses as determined by the department chair.

Curriculum

A total of 33 semester credit hours is required for

graduation, distributed between core and elective areas as follows:

Core Curriculum (15 credits)

There are five core courses covering the following content areas:

CH 10-19	Thermodynamics
CH 20-29	Transport Phenomena
CH 30-39	Chemical Kinetics, Catalysis, and Reactor Design
CH 40-49	Systems Analysis and Design
CH 50-59	Chemical Engineering Mathematics

Not all courses in the CH area are accepted as core courses. Students should refer to the listing of the individual courses online at www.ntu.edu to ensure that the letter C is included in the brackets following the designation of CH (e.g., CH [C]).

Electives (18 credits)

Students will take a minimum of six elective courses. Two of these courses must be in Chemical Engineering, selected from the core areas listed above or from other Chemical Engineering offerings. The remainder of the electives may be chosen from courses identified in the bracket line by CH [E], subject to approval by the student's advisor.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her NTU advisor, a thesis option is available. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

The thesis can be used to replace six credits of electives; however, two elective courses must still be in Chemical Engineering.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

MS in Computer Engineering

The Computer Engineering program prepares students to work in the dynamic and rapidly expanding field of digital technology. Computer engineers design computers and computer systems, apply computers as components of larger systems, and apply digital techniques to solve a broad range of engineering problems.

NTU's Master of Science degree program in Computer Engineering requires a minimum of 30 credits, consisting of four core courses, four specialization courses, and two elective courses. The curriculum features substantial choice of specialization and elective courses, thereby enabling students to tailor the program of study to meet their specific needs and fulfill their particular aspirations. The advanced portion of the curriculum remains open-ended, to encourage students to take advantage of new courses that concentrate on the latest developments in the field.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU, whose work schedules preclude full-time study, should expect to fulfill the requirements within five years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Computer Engineering program:

- BS degree in computer engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 30 credits for graduation. These credits must satisfy the following distribution requirement: four core courses, four specialization courses, and two elective courses.

Core Curriculum (12 credits)

The core curriculum consists of four courses and allows students to develop knowledge across a broad spectrum of topics related to computer engineering. Students select courses from a specified set of courses covering computer architecture, digital systems, integrated circuits, software engineering, computer networks, and operating systems. Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (12 credits)

Students select at least four courses from a specialization that represents the technical emphasis most compatible with their educational and career goals. Areas of specialization for Computer Engineering include computer architecture, digital systems, signal processing, real-time and embedded systems, and software systems. Students should consult an advisor or visit the NTU Web site for information about currently offered specialization areas and courses available in those areas.

Electives (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses to meet the elective requirement and to bring their total credits to a minimum of 30. Elective courses are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to select appropriate elective courses.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available and may be substituted for the elective courses. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP

increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following list of courses illustrates the choice of academic material available to students wishing to obtain an MS in Computer Engineering. Individual course descriptions may be found on the NTU Web site at www.ntu.edu. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Core Courses (12 credits)

Students must take the following courses to satisfy the core requirement:

Both of the following courses:

CA 714	Graduate Computer Architecture
SE 710	Software Engineering

One of the following courses:

ST 759	Data Communication Networks
CS 740	Operating Systems Principles

One of the following courses:

DS 510	Digital ASIC Design
IC 541	Introduction to Digital Integrated Circuits

Specialization Courses (12 credits)

Students select four courses from one specialization area to satisfy this requirement. Courses for three specialization areas are listed below. Please consult an advisor or visit the NTU Web site for information about other specialization areas and courses available in those areas.

Computer Architecture

CA 712	Digital Systems Design
CA 720	Parallel Computer Architecture
CA 722	Computer Networks—Architecture, Protocols, and Standards
CA 765	Realtime Systems
DS 765	Digital System Design with Hardware Description Language
DS 766	Digital System Design and Interfacing with Verilog
DS 770	Testing and Diagnosis of VLSI Systems
DS 780	Fault Tolerant Systems
IC 752	Computer-Aided Engineering for Integrated Circuits
CS 765	Distributed Computing Systems

Digital Systems

CC 560	Digital Signal Processing
CC 715	Digital Communications
CC 760	Analog and Digital Filter Design
CC 764	VLSI Signal Processing
DS 765	Digital System Design with Hardware Description Language
DS 766	Digital System Design and Interfacing with Verilog
DS 770	Testing and Diagnosis of VLSI Systems
IC 742	Advanced Digital Integrated Circuits
IC 752	Computer-Aided Engineering for Integrated Circuits

Software Systems

SE 531	Advanced Java Programming
SE 538	XML, Java, and the Enterprise
SE 730	Object-Oriented Analysis and Design
ST 765	Cryptography
ST 550	Computer Networking
ST 750	Data Communications
CS 720	Programming Language Principles
CS 730	Compilers
CS 741	Advanced Operating Systems
CS 750	Information Systems
ST 731	Simulation
ST 740	Computer Graphics

Elective Courses (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

Foundation Courses

Foundation courses are available for those students who do not have an adequate preparation to begin a master's program in Computer Engineering. Undergraduate Foundation courses for students entering graduate study in Computer Engineering are available in the topical areas given below. Foundation courses cannot be taken for graduate credit. Please see the NTU Web site for a current set of Foundation courses.

AD 310-319	Data Structures (formerly BC 30-39 Data Structures)
CA 310-319	Computer Architecture (formerly BC 60-69 Digital System Design—Computer Architecture)
CA 360-369	Microcomputers and Embedded Computer Systems (formerly BC 40-49 Microprocessors and Assembly Level Programming)
CM 310-319	Mathematical Logic and Automata Theory (formerly BC 80-89 Discrete Structures)
CS 340-349	Operating Systems (formerly BC 50-59 Operating System Principles)

- DS 360-369 Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
- SE 330-339 Analysis and Design Techniques (formerly BC 10-19 Fundamentals of Computer Engineering)

MS in Computer Science

Computer science is the body of knowledge dealing with the design, analysis, implementation, efficiency, and application of algorithmic processes that transform information. It deals with software, operating systems, programming languages, and other related areas.

The Master of Science in Computer Science requires 30 credits of graduate work, consisting of 12 credits of core courses, 12 credits of specialization courses, and six credits of elective courses. The curriculum features a substantial choice of specialization and elective courses, thereby enabling students to tailor the program to meet their specific needs and fulfill their particular aspirations. The advanced portion of the curriculum remains open-ended to encourage students to take advantage of new courses that concentrate on the latest developments in the field.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU, whose work schedules preclude full-time study, should expect to fulfill the requirements within five years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet all of the following eligibility requirements for regular admission into the Computer Science program:

- BS degree in computer science.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 30 credits for graduation. These courses must satisfy the following distribution requirement:

Core Curriculum (12 credits)

The core curriculum consists of 12 credits and allows students to develop knowledge across a broad spectrum of topics related to computer science. Students select courses from a specified set of courses covering data structures, algorithms, programming languages, databases, and software engineering. Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (12 credits)

Students select at least four courses from an area of specialization that represents the technical emphasis most compatible with their educational and career goals. Areas of specialization for Computer Science include Algorithms and Complexity, Artificial Intelligence, Data Management, and Web Applications. Students should consult an advisor or visit the NTU Web site for information about currently offered specialization areas and courses available in those areas.

Electives (6 credits)

Students may select six elective credits from any of NTU's graduate-level courses to meet the elective requirement and bring their total credits to a minimum of 30. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to select appropriate elective courses.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available and may be substituted for the elective courses. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when

course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following list of courses illustrates the choice of academic material available to students who want to obtain an MS in Computer Science. Individual course descriptions may be found on the NTU Web site at www.ntu.edu. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Core Courses (12 credits)

Students must select four of the following courses to satisfy the core requirement:

AD 711	Advanced Data Structures
AD 720	Analysis of Algorithms
CS 720	Programming Language Principles
CS 750	Database Management Systems
SE 710	Software Engineering

Specialization Courses (12 credits)

Students select 12 credits from one specialization area to satisfy this requirement. Courses for several specialization areas are listed below. Please consult an advisor or visit the NTU Web site for information about other specialization areas and courses available in those areas.

Algorithms and Complexity

AD 721	Sequential and Parallel Algorithms
AD 726	Genetic Algorithms
CA 710	Introduction to Parallel Processing
CM 710	Formal Languages and Computation Theory
CS 758	Data Mining
IS 794	Machine Learning
IS 773	Neural Computation
ST 741	Advanced Computer Graphics and Computer-Aided Design

Artificial Intelligence

AD 726	Genetic Algorithms
CS 758	Data Mining
CT 780	Robotics
IS 710	Artificial Intelligence Concepts
IS 720	Knowledge System Engineering
IS 755	Artificial Agents
IS 773	Neural Computation
IS 794	Machine Learning

Data Management

CS 755	Distributed Database Design
CS 758	Data Mining
CS 760	Client/Server Computing
CS 765	Distributed Computing Systems
CS 780	Advanced WWW Technologies
ST 760	Information System Security

Web Applications

CS 760	Client/Server Computing
CS 761	Network Computing
CS 765	Distributed Computing Systems
CS 780	Advanced WWW Technologies
SE 531	Advanced Java Programming
SE 538	XML, Java, and the Enterprise
SE 540	Java Distributed Enterprise Computing
SE 735	Design of Interface Systems
SE 736	Enterprise Software Development
SE 750	Software Testing and Verification
SE 754	Object-Oriented Testing and Reliability
ST 760	Information System Security

Elective Courses (6 credits)

Students may select elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

Foundation Courses

Foundation courses are available for those students who do not have an adequate preparation to begin a master's program in Computer Science. Undergraduate Foundation courses for students entering graduate study in Computer Science are available in the topical areas given below. Foundation courses cannot be taken for graduate credit. Please see the NTU Web site for a current set of Foundation courses.

AD 310-319	Data Structures (formerly BC 30-39 Data Structures)
CM 310-319	Mathematical Logic and Automata Theory (formerly BC 80-89 Discrete Structures)
SE 330-339	Analysis and Design Techniques (formerly BC 10-19 Fundamentals of Computer Engineering)

MS in Electrical Engineering

NTU's MS in Electrical Engineering program is designed to provide students with the technical background for the analysis, design, development, operation, or research of electrical or electronic systems. Subject areas include communications, control, electric power, electromagnetics, electronics, signal processing, and integrated circuits.

The curriculum features substantial choice of courses, thereby enabling students to customize programs to meet their specific needs and fulfill their particular aspirations. Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU, whose work schedules prevent full-time study, should expect to fulfill the requirements within five years by registering for two or three courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Electrical Engineering program:

- BS degree in electrical engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.*
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

*Applicants without undergraduate degrees in electrical engineering will be required to complete Foundation courses prior to full admission to the program.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 33 credits for graduation. The curriculum offers specializations in the following sub-areas of electrical engineering:

- Communications
- Controls
- Electromagnetics
- Integrated Circuits
- Power Systems

Course requirements are specific to each specialization. For all specializations, the 33 credits must satisfy the following distribution requirements: three core courses, six concentration courses, and two elective courses.

Core Curriculum (9 credits)

The core curriculum consists of three courses and enables students to develop knowledge in topics basic to a specialized area of electrical engineering. Students should complete the core courses prior to pursuing concentration and elective courses.

Concentrations (18 credits)

Within each specialization, students select at least six courses from an area of concentration that represents the technical emphasis most compatible with their educational or career goals. Areas of concentration include signal processing, data communications, control systems, RF and microwaves, optics, digital integrated circuits, analog integrated circuits, industrial power systems, and power electronics. Students should consult an advisor or visit the NTU Web site for information about currently offered concentration areas and courses available in those areas.

Electives (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses to meet the elective requirement and to bring their total credits to a minimum of 33. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to select appropriate elective courses.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available and may be substituted for the elective courses. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following list of courses illustrates the choice of academic material available to students wishing to obtain an MS in Electrical Engineering. Individual course descriptions may be found on the NTU Web site at www.ntu.edu. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Communications Specialization

Core Courses (9 credits)

Students must take the following courses to satisfy the core requirement:

CC 511	Communications Systems
CC 560	Digital Signal Processing
CC 714	Random Processes for Engineering Applications

Concentration Courses (18 credits)

Students select six courses from one concentration area to satisfy this requirement. Courses for several concentration areas in the Communications specialization are given below. Students should consult an advisor or visit the NTU Web site for information about other concentration areas and courses available in those areas.

Data Communications

CC 714	Random Processes for Engineering Applications
CC 715	Digital Communications
CC 731	Estimation Theory
CC 740	Error Correction Coding
CC 745	Information Theory
CC 763	Advanced Digital Signal Processing
CC 781	Spread Spectrum and CDMA
CC 782	Computer Communications
CC 784	Broadband Networks and Multimedia Communications
CC 786	Principles of Broadband ISDN and ATM
CS 761	Network Computing
EM 513	Fiber Communications and Systems

ST 550	Computer Networking I
ST 750	Data Communications
ST 754	Internet and Higher Layer Protocols
ST 760	Information Systems Security
ST 765	Cryptography
TC 502	Introduction to Telecommunications
TC 583	Telecommunications Management and Regulation
TC 741	Telecommunications Network Design
TC 751	Wireless, Cellular, and Personal Telecommunications
TC 758	Wireless Internet
TC 774	Management of Telecommunications

Signal Processing

CC 714	Random Processes for Engineering Applications
CC 731	Estimation Theory
CC 740	Error Correction Coding
CC 745	Information Theory
CC 760	Analog and Digital Filter Design
CC 763	Advanced Digital Filter Design
CC 764	VLSI Signal Processing
CC 766	Adaptive Signal Processing
CC 767	Electronics of Analog Signal Processing

Telecommunications and Communications Networks

CC 714	Noise in Linear Systems
CC 715	Digital Communications
CC 740	Error Correction Coding
CC 745	Information Theory
CC 782	Computer Communications
CC 784	Broadband Networks and Multimedia Communications
CC 786	Principles of Broadband ISDN and ATM
EM 513	Fiber Communications and Systems
EM 714	Advanced Fiber Optics
EM 715	Optical Detectors and Detector Systems
TC 502	Introduction to Telecommunications
TC 741	Telecommunications Network Design
TC 745	Wireless Networks
TC 751	Wireless, Cellular, and Personal Telecommunications

Wireless Communications

CC 714	Noise in Linear Systems
CC 718	Wireless Networks
CC 731	Estimation Theory
CC 740	Error Correction Coding
CC 745	Information Theory
CC 781	Spread Spectrum and CDMA
EM 530	Microwave Engineering I
EM 531	Microwave Engineering II
EM 552	Antennas and Radiowave Propagation for Personal Communications
EM 732	Microwave Devices and Circuits
EM 735	Microwave and RF Wireless Systems
EM 736	Active Microwave Circuits

EM 740	Electromagnetic Theory I
EM 750	Antenna Theory and Design
TC 502	Introduction to Telecommunications
TC 741	Telecommunications Network Design
TC 751	Wireless, Cellular, and Personal Telecommunications

Controls Specialization

Core Courses (9 credits)

Students must take the following courses to satisfy the core requirement:

CT 520	Feedback Control Systems
CT 712	Linear Systems Theory
CT 721	Control Systems Design

Concentration Courses (18 credits)

Students select six courses from one concentration area to satisfy this requirement. Courses for a concentration in the Controls specialization are given below. Students should consult an advisor or visit the NTU Web site for information about other concentration areas and courses available in those areas.

CT 570	Digital Control Systems
CT 741	Nonlinear Control
CT 511	Continuous System Modeling
CT 521	Principles of Mechatronic Control
CT 711	Dynamics of Controlled Systems
CT 722	Linear Control and Design for Multivariable Systems
CT 723	System Identification and Adaptive Control
CT 791	Modeling and Control of Electromechanical Systems

Electromagnetics Specialization

Core Courses (9 credits)

Students must take the following courses to satisfy the core requirement:

EM 740	Electromagnetic Theory I
MA 584	Ordinary Differential Equations
MA 780	Mathematical Methods for Science and Engineering

Concentration Courses (18 credits)

Students select six courses from one concentration area to satisfy this requirement. Courses for two concentration areas in the Electromagnetics specialization are given below. Students should consult an advisor or visit the NTU Web site for information about other concentration areas and courses available in those areas.

Optics

EM 513	Fiber Communications and Systems
EM 711	Introduction to Fourier Optics
EM 714	Advanced Fiber Optics
EM 715	Optical Detectors and Detector Systems
EM 718	Diffraction and Interferometry
EM 721	Introduction to Lasers
EM 722	Integrated Optics
CC 714	Random Processes for Engineering Applications

RF and Microwaves

EM 530	Microwave Engineering I
EM 531	Microwave Engineering II
EM 552	Antennas and Radiowave Propagation for Personal Communication
EM 732	Microwave Devices and Circuits
EM 735	Microwave and RF Wireless Systems
IC 545	RF Integrated Circuits
EM 750	Antenna Theory and Design
CC 510	Introduction to Communications and Signal Processing (formerly CC 510)
CC 511	Communications Systems
CC 714	Random Processes for Engineering Applications
CC 718	Wireless Networks
CC 781	Spread Spectrum and CDMA
CC 787	RF Electronics for Wireless Communication

Integrated Circuits Specialization

Core Courses (9 credits)

Students must take the following courses to satisfy the core requirement:

IC 520	Integrated Circuit Devices
CR 526	Design-Oriented Analysis of Electronic Circuits
IC 762	Computer-Aided Engineering for Integrated Circuits

Concentration Courses (18 credits)

Students select six courses from one concentration area to satisfy this requirement. Courses for several concentration areas in the Integrated Circuits specialization are given below. Students should consult an advisor or visit the NTU Web site for information about other concentration areas and courses available in those areas.

Analog Integrated Circuits

IC 534	Microelectronics Test Engineering
IC 570	Linear Integrated Circuits
IC 771	Advanced Analog Integrated Circuits
IC 776	Analysis and Design of VLSI-Analog-Digital Interface Integration
CC 760	Analog and Digital Filter Design
CR 551	Analog Signal Processing and Filtering
CT 712	Linear Systems Theory

Digital Integrated Circuits	
IC 541	Introduction to Digital Integrated Circuits
IC 742	Advanced Digital Integrated Circuits
IC 776	Analysis and Design of VLSI-Analog-Digital Interface Integration
DS 710	Digital Hardware Synthesis
DS 765	Digital System Design with Hardware Description Languages
DS 766	Digital System Design and Interfacing with Verilog
DS 770	Testing and Diagnosis of VLSI Systems

Integrated Circuits for Communications	
IC 545	RF Integrated Circuits
IC 570	Linear Integrated Circuits
IC 574	Integrated Circuits for Communications
IC 775	Advanced Integrated Circuits for Communications
IC 776	Analysis and Design of VLSI-Analog-Digital Interface Integration
IC 732	Microwave Devices and Circuits
IC 735	Microwave and RF Wireless Systems
CC 511	Communication Systems
CC 760	Analog and Digital Filter Design
CR 551	Analog Signal Processing and Filtering
CT 712	Linear Systems Theory
CC 50	Introduction to Communications and Signal Processing
CC 714	Random Processes for Engineering Applications
CC 787	RF Electronics for Wireless Communications

Power Systems Specialization

Core Courses (9 credits)
 Students must take the following courses to satisfy the core requirement:

CM 740	Advanced Numerical Analysis
CT 712	Linear Systems Theory
EM 740	Electromagnetic Theory I

Concentration Courses (18 credits)
 Students select six courses from one concentration area to satisfy this requirement. Courses for several concentration areas in the Power Systems specialization are given below. Students should consult an advisor or visit the NTU Web site for information about other concentration areas and courses available in those areas.

Bulk Power Systems	
PS 512	Power Systems Analysis
PS 713	Analysis of Distribution Systems
PS 752	Power System Stability
PS 755	Power System Protection

PS 757	Power Quality Phenomena in Power Systems
PS 761	Power Economics and Regulation
PS 735	Direct Energy Conversion
PS 562	Electricity Resource Planning
PS 760	Power System Operation in a Less Regulated Environment
PS 731	Energy Conversion

Industrial Power Systems	
PS 512	Power Systems Analysis
PS 713	Analysis of Distribution Systems
PS 530	Introduction to Electric Drive Systems
PS 734	Dynamics and Control of AC Drives
PS 730	Electric Machinery Analysis
PS 742	Solid-State Power Conversion
PS 755	Power System Protection

Power Electronics and Drives	
PS 512	Power Systems Analysis
PS 713	Analysis of Distribution Systems
PS 530	Introduction to Electric Drive Systems
PS 734	Dynamics and Control of AC Drives
PS 741	Power Electronics
PS 747	Power Electronics II
PS 749	Power Electronics III

Elective Courses (6 credits)
 Students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

Foundation Courses
 Foundation courses are available for those students who do not have an adequate preparation to begin a master's program in Electrical Engineering. Undergraduate Foundation courses for students entering graduate study in Electrical Engineering are available in the topical areas given below. Foundation courses cannot be taken for graduate credit. Please see the NTU Web site for a current set of Foundation courses.

CC 310-319	Communications Systems (formerly BE 40-49 Systems)
CR 310-319	General Circuit Theory (formerly BE 10-19 Circuits)
DS 360-369	Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
EM 340-349	Electromagnetic Field Theory (formerly BE 30-39 Electromagnetics)
IC 320-329	Electronic Devices and Modeling (formerly BE 20-29 Electronics)
PS 330-339	Energy Conversion (formerly BE 50-59 Systems)

MS in Engineering Management

The Master of Science in Engineering Management program has been designed with significant industry input to provide a broad technical management educational experience for engineers and other scientific professionals. The program is especially suited for engineers moving into their first management position or, with proper advising and course selection, can help those who already have some management experience.

Several course options are available, but all require some technical tools—probability and statistics, operations research, accounting and/or finance, project management, and others. Students can take their electives in a management or technical area to best fit their personal goals and objectives. A final three-hour capstone project requires students to integrate and synthesize their experiences.

The program requires a minimum of 33 semester credits consisting of core courses, elective courses, and a capstone project. Students enrolled through NTU could fulfill the degree requirements in two-and-a-half years by registering for at least four courses per year and completing the capstone project as an additional course in the final year. Students should complete the degree within five years by taking two to three courses per year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Engineering Management program:

- BS degree in engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- At least two years of engineering work experience.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status see the Admission section of this bulletin.

Curriculum Overview

A total of 33 credit hours is required for graduation. Students will complete seven core courses (21 credits), three electives from any of NTU's graduate-level courses (9 credits), and an engineering management capstone course (3 credits).

Core Curriculum (21 credits)

Required Core Courses (12 credits)

The core curriculum begins with four required courses in the following topic areas, as outlined below under the Program of Study Plan:

- Introduction to Engineering Management
- Operations Research
- Organizational Behavior
- Probability and Statistics for Engineers

Students should complete the required core courses prior to pursuing the remaining core and elective courses.

Additional Core Courses (9 credits)

Students complete the core curriculum by selecting three additional courses in the following areas:

- Economic Decision Analysis
- Finance and Accounting
- Marketing
- Project Management
- Technology and Operations Management

Electives (9 credits)

Students may select three additional courses from the NTU graduate catalog to meet the elective requirement and bring their total credits to a minimum of 33. Elective credits are designed to give each student an opportunity to tailor their program to their individual and organizational goals and needs. Students must consult with an NTU advisor to confirm they have the appropriate prerequisite knowledge and to ensure that the electives are appropriate to their Program of Study Plan.

Capstone Project (3 credits)

In the last semester of the program, or after all other core courses and electives have been met, students are to enroll in the three-credit capstone course, which involves conducting a project and writing a report relevant to the practice of engineering management. This assignment is to be negotiated with and carried out under the direction of a qualified faculty person. The project might involve the role of government, entrepreneurship, and/or professional ethics; sponsors of enrolled students may be able to suggest projects of importance. See the NTU Web site for more details.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

Individual course descriptions may be found on the NTU Web site at www.ntu.edu. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Core Courses (21 credits)

Required Core Courses (12 credits)

MB 710	Engineering Management
MA 520	Probability and Statistics for Engineers
QM 710	Operations Research
NB 720	Organizational Behavior—Working Within the Equations of State

Additional Core Courses (9 credits)

One course from the following:

NB 750	Accounting and Finance—Measurement and Flow Control for the Economic Engine
EF 735	Economic Decision Analysis

One course from the following:

TO 735	Marketing of Advanced Technologies
NB 730	Marketing—Maximizing the Organizational I/O Bus

One course from the following:

TO 760	Project Management Systems
TO 761	Advanced Topics in Project Management
TO 580	Production and Operations Management
NB 710	Technology and Operations—Moore's Law and Other Business Accelerators

Elective Courses (9 credits)

Students will select three elective courses from any of NTU's graduate-level courses, provided the student has the appropriate prerequisite knowledge and approval of an NTU advisor.

Suggested electives include the following:

NB 721	Leadership and Teamwork—Momentum Transfer Using Power, Influence, and Collaboration
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SP 560	Manufacturing Management Practices
MG 723	Supply Chain Management

Capstone Course (3 credits)

MB 780	Engineering Management Capstone Project
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MS in Environmental Systems Management

NTU is currently not accepting applications to this program. The following information is intended for students admitted prior to September 2003.

Many sites in this country, ranging from industrial plants and municipal landfills to government nuclear facilities and industrial petrochemical plants, contain a myriad of environmental or hazardous wastes. All of these sites have an ecological impact and pose some level of threat to human health. These health and ecosystem hazards include water contamination, air pollution, food supply poisoning, and species extinction.

Good management of such a critical, technical, and complicated task is essential to successful cleanup efforts and to appropriate pollution-prevention technologies and waste-stream reduction protocols. Managers who are well versed in the technical aspects are needed from among those who have the scientific and engineering skills to do the job but have not yet developed appropriate management skills or up-to-date subject knowledge.

Toward that end, the MS in Environmental Systems Management program allows students to further develop their knowledge in the subjects of environmental systems, waste systems, prevention technologies, and management skills.

The program requires 30 semester credit hours, consisting of core and elective courses. Completion of the curriculum should require one-and-a-half to two years of full-time graduate study. Part-time students should expect to fulfill the degree requirements in two to four years, depending on their course load.

Admissions Requirements

NTU is currently not accepting applications to this program. The following information is intended for students admitted prior to September 2003.

The program is designed for professionals with degrees in engineering or the "hard sciences" (e.g., biology, chemistry, physics, geology). Students are expected to have completed college mathematics courses through ordinary differential equations;

however, this is not a requirement for admission to the program. Within a year after acceptance into the program, students lacking this background will be required to have completed courses to fulfill this requirement.

Curriculum

A total of 30 semester credit hours is required for the Environmental Systems Management degree, distributed between core and elective areas as follows:

Core Curriculum (12 credits)

Students must complete four core courses, including one course on basic principles of environmental systems management, one course on systems engineering, and two courses selected from the following three areas: Laws and Regulations, Risk Assessment, and Fate and Transport. (No more than one course from any area is permitted.)

One course from each of the following areas:

Environmental Systems Management (EV 05-09)
Systems Engineering (QM or SY designation)

One course from two of the following three areas:

Laws and Regulations (EV 10-14)
Risk Assessment (EV 20-24)
Fate and Transport (EV 25-29)

Students are advised to refer to the listing of individual courses at www.ntu.edu to ensure that the letter C is included in the brackets following the designation of ESM (e.g., ESM [C]).

Depth Requirement (12 credits)

Students must complete four courses from depth areas from the following two areas covering management and technical subjects. Advisors may authorize course substitutions.

Technology (9 credits)

Three courses in the Technology area, with at least one course from each of the two sub-areas listed below:

Treatment (EV 40-45)
Source Reduction/Minimization (PD designation)

Management (3 credits)

One course in the Management area with the MB 10-19 designation.

To meet this requirement, the letter D must appear in the brackets following the designation of ESM [] for these courses.

Electives (6 credits)

Elective courses may be chosen from a variety of support areas. Students are encouraged to contact their advisors to discuss electives that would be appropriate for their Program of Study Plan.

To meet the elective requirement, courses must have the designation [E] in the ESM brackets following the course title and institution. Selection of elective courses should be made in consultation with the faculty advisor.

Suggested Electives

- Chemical Engineering (CH)
- Mechanical Engineering (ME)
- Systems Engineering (QM or SY designation)
- Water Applications (EV 50-59)
- Air Applications (EV 60-64)
- Land Applications (EV 65-69)
- Hazardous Waste (EV 75-79)
- Science/Engineering (EV 80-89)
- Special Topics (EV 90-94)

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

MS in Manufacturing Systems Engineering

The competitiveness of a modern manufacturing firm requires an interdisciplinary viewpoint of its employees, one that can be gained through completion of NTU's MS in Manufacturing Systems Engineering. This degree program is designed to educate the engineers who will be most capable of contributing to the solution of the many broad problems in today's information-intensive manufacturing industries. The program's objective is to provide a graduate-level degree for engineers who will work in the design, implementation, operation, and management of modern, information-based manufacturing systems that serve as the genesis for manufactured products supporting virtually every aspect of the modern way of life. The students in this program learn technical skills that are typically not taught in undergraduate courses and management skills essential to keep industry moving in the right direction. Graduates will receive an interdisciplinary education that presents their employers an alternative to hiring engineers with specialized degrees for manufacturing-related positions.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU should expect to fulfill the requirements in three to five years, depending on the course load they choose.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Manufacturing Systems Engineering program:

- BS degree in engineering from an ABET-accredited engineering program in the United States, or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 33 credits, including at least 18 core credits, nine specialization credits, and six elective credits.

Core Curriculum (18 credits)

Students must complete three required core courses in the following areas, as well as at least three additional courses from a broader list in the same areas:

- Design and Analysis of Manufactured Products
- Control of Manufacturing Processes and Systems
- Management of Manufacturing Processes and Systems

Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (9 credits)

Students must complete at least nine specialization credits, consisting of at least three additional courses from the core Manufacturing Systems Engineering areas.

Electives (6 credits)

Students select two additional courses from the NTU graduate catalog to meet the elective requirement and bring their total credits to a minimum of 33. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to confirm they have the appropriate prerequisite knowledge.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following course list illustrates the flexibility available to students who want to specialize in specific areas of Manufacturing Systems Engineering. Individual course descriptions may be

found on the NTU Web site at www.ntu.edu.
Specific courses and course requirements may change. Updates will be posted on the NTU Web site.

Core Courses (18 credits)

Required Courses

PD 525 Integrated Design and Manufacturing
SP 510 Modeling Manufacturing Systems
SP 560 Manufacturing Management Practices

Additional Courses

Three courses from the following:

Design and Analysis of Manufactured Products

PD 720 Materials and Manufacturing Considerations
in Design
PD 547 Nontraditional Manufacturing Processes
PD 580 Microelectronics Manufacturing and the
Environment

Control of Manufacturing Processes and Systems

PD 763 Automated Production
PD 570 Computer Integrated Manufacturing Systems
SP 720 Advanced Production Control

Management of Manufacturing Processes and Systems

PD 522 Design for Manufacturability and Concurrent
Engineering
SP 565 Modern Manufacturing Methods and Systems
SP 745 Principles of Worldclass Manufacturing

Specialization Courses (9 credits)

Three courses from any of the following:

Design and Analysis of Manufactured Products

IC 503 Microelectronic Packaging Materials
IC 730 Advanced Microelectronic Processing
ME 580 Introduction to Solid Mechanics
ME 596 Introduction to Microelectromechanical
Systems (MEMS)
MS 715 Materials Microstructure

Control of Manufacturing Processes and Systems

CT 520 Feedback Control Systems
CT 570 Digital Control Systems
CT 780 Robotics
ME 523 Computer-Aided Analysis and Design of
Mechanical Systems
TO 580 Production and Operations Management

Management of Manufacturing Processes and Systems

MB 710 Introduction to Engineering Management
MB 512 Managing Technology and Innovation
SY 710 Systems Engineering Process
TO 712 eCommerce Technologies
TO 750 Total Quality Management

Elective Courses (6 credits)

Any two additional graduate-level courses offered by NTU provided the student has the required pre-requisite knowledge specified in the course descriptions.

MS in Materials Science and Engineering

NTU is currently not accepting applications to this program. The following information is intended for students admitted prior to September 2003.

Materials science and engineering is the study of the structure, properties, processing, and performance of materials. The field covers the behavior of numerous classes of materials: metals, ceramics, glasses, polymers, electronic materials, and composites. There are no specific courses required for this program: the flexibility of course choice reflects the interdisciplinary nature of the field.

Admissions Requirements

NTU is currently not accepting applications to this program. The following information is intended for students admitted prior to September 2003.

The curriculum developed by NTU is intended to accommodate individuals whose backgrounds come from the spectrum identified with materials science, engineering, and the physical sciences.

Curriculum

Core Curriculum

Each student must complete a minimum of 33 graduate credits.

Candidates are required to complete 15 credits of Depth courses (designated as MAT [D]), 12 credits of Breadth courses (designated as MAT [B]), and six credits of Electives (designated as MAT [E]). In general, the courses with numbers CH 61-62, EP 10-49, IC 10-30, MC 10-59, MP 20-59, and MS 11-29 are designated as MAT [B, D, E] and can be applied to any category. Students are expected to demonstrate proficiency in each of the four components of the materials science field, namely: performance, processing, properties, and structure. To achieve proficiency in these four components, students are encouraged to choose at least one course from each of the following categories:

Performance

MC 60-69 Non-Destructive Testing
MS 30-39 Materials Degradation

Processing

MS 10-19 General Materials Science
MS 20-29 Thermodynamics and Kinetics
MP 50-59 Deformation Processing

Properties

EP 10-49 Electrical Properties
MP 10-49 Mechanical Properties

Structure

MS 50-59 Electronic, Atomic, and Molecular Arrangements
MC 10-59 Materials Characterization
PM 20-49 Polymeric Materials

Students are encouraged to discuss their interests and career goals with their advisors before preparing their Program of Study Plan.

Specializations

The Materials Science and Engineering curriculum offers courses in a number of specialized areas, such as the following:

- Mechanical Aspects of Materials
- Electrical and Physical Aspects of Materials
- Chemical Aspects and Polymeric Materials
- Microanalysis and Characterization of Materials
- Processing of Materials

Students may elect—with the help of their advisors—to tailor this program to emphasize any of these areas. To provide additional flexibility, students may choose a three-credit project course. This course provides an opportunity for the student to study a special topic that is not available through regular course offerings. The project is proposed by the student in consultation with a designated NTU faculty member who also grades the project.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan (PSP)

Admitted students should submit a Program of Study (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP

increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

MS in Mechanical Engineering

Mechanical Engineering is concerned with the principles of motion, force, and energy and how they are transformed, usually through machinery, in a safe, efficient, and reliable manner. Subfields of mechanical engineering include mechanics, combustion, fluid mechanics, heat transfer, materials, control, and thermodynamics.

NTU's Master of Science degree program in Mechanical Engineering requires 33 credits, consisting of three types of courses: core, specialization, and elective. The non-thesis curriculum option features specializations that enable students to customize the program to meet their specific needs. The Mechanical Engineering program also offers a thesis option that allows students to gain research experience.

Core courses provide technical literacy applicable to all areas of mechanical engineering. The three required courses represent fundamentals in control theory, engineering mechanics, and statistics. The specialization courses allow students to advance their studies in a particular area of mechanical engineering. Elective courses allow students to tailor the remainder of their program even further to meet their individual educational and career goals.

Completion of the curriculum will take approximately one-and-a-half years of full-time graduate study. Students enrolled through NTU, whose work schedules preclude full-time study, can expect to fulfill the requirements within six years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Mechanical Engineering program:

- BS degree in mechanical engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 33 credits, including at least three core courses, six specialization courses, and two additional elective courses.

Core (9 credits)

The core curriculum consists of three courses that allow students to develop knowledge in areas that have general application across the discipline of mechanical engineering. Students complete one course in each of the following areas:

- Controls
- Engineering Mechanics
- Statistics

Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (18 credits)

Students will select at least six courses from an area of specialization that represents the technical emphasis most compatible with their educational or career goals. Mechanical Engineering specialty areas include the following:

- Dynamics and Controls
- Manufacturing
- Materials
- Mechanical Systems
- Thermal-Fluids

Electives (6 credits)

Students select two additional courses from the NTU graduate catalog to meet the elective requirement and bring their total credits to a minimum of 33. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs.

Students are encouraged to consult with an NTU advisor to confirm they have the appropriate prerequisite knowledge.

Thesis Option

When desirable and appropriate, a thesis option is available for students wanting to pursue in-depth projects or research experience. Six credits toward a thesis count toward fulfillment of the elective requirement. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following course list illustrates the flexibility available to students who want to specialize in specific areas of Mechanical Engineering. Individual course descriptions may be found on the NTU Web site at www.ntu.edu. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Core Courses (9 credits)

Students must take the following three courses to satisfy the core requirement:

CT 520	Feedback Control Systems
MA 520	Probability and Statistics for Engineers
ME 517	Vibrations

Specialization Courses (18 credits)

Students select six courses from one specialization area to satisfy this requirement.

Dynamics and Control

ME 710	Advanced Dynamics
CT 711	Dynamics of Controlled Systems
ME 714	Advanced Machine Design
CT 570	Digital Control Systems
CT 712	Linear Systems Theory
CT 741	Nonlinear Control
CT 773	Computer Control of Machines and Processes
CT 770	Sample Data and Digital Control Systems
CT 780	Robotics
ME 597	Design of Electromechanical Systems
ME 596	Introduction to Micro-electromechanical Systems

Manufacturing

PD 720	Materials and Manufacturing Considerations in Design
PD 710	Design for Manufacturing and Assembly
PD 525	Integrated Design and Manufacturing
PD 547	Nontraditional Manufacturing Processes
PD 575	Flexible Manufacturing Systems
SP 565	Modern Manufacturing Methods and Systems
PD 720	Advanced Production Control

TO 750	Total Quality Management
TO 751	Methods for Quality Improvement
PD 580	Microelectronics Manufacturing and the Environment
CT 773	Computer Control of Machines and Processes

Materials

ME 714	Advanced Machine Design
ME 549	Modeling in Materials Processing
ME 580	Introduction to Solid Mechanics
ME 582	Failure Mechanisms in Engineering Mechanics
ME 583	Failure Analysis of Mechanical Components
ME 535	Corrosion in Metals
ME 735	Defects in Materials
MP 742	Composite Materials
MS 715	Materials Microstructure
IC 503	Microelectronic Packaging Materials
MP 724	Mechanical Behavior of Engineering Materials
PD 720	Materials and Manufacturing Considerations in Design
ME 597	Nanotechnology

Mechanical Design

ME 710	Advanced Dynamics
ME 711	Advanced Kinematics—Advanced Machines and Mechanisms
ME 714	Advanced Machine Design
ME 516	Vehicle Dynamics
ME 521	Finite Element Analysis with Applications
ME 523	Computer-Aided Analysis and Design of Mechanical Systems
ME 582	Failure Mechanisms in Engineering Mechanics
ME 583	Failure Analysis of Mechanical Components
ME 597	Design of Electromechanical Systems
ME 596	Introduction to Micro-electromechanical Systems
PD 720	Materials and Manufacturing Considerations in Design

Thermal Fluid Systems

ME 541	Intermediate Fluid Mechanics
ME 741	Advanced Fluid Mechanics
ME 530	Intermediate Heat Transfer
ME 730	Advanced Heat Transfer
ME 772	Advanced Thermodynamics
ME 746	Computational Fluid Mechanics
ME 550	Combustion
ME 753	IC Engines
ME 754	Gas Turbines and Jet Propulsion
ME 755	Fluid Power—Hydraulics
MA 780	Mathematical Methods for Science and Engineering

Elective Courses (6 credits)

Any two additional graduate-level courses offered by NTU provided the student has the required prerequisite knowledge specified in the course descriptions.

MS in Microelectronics and Semiconductor Engineering

The Microelectronics and Semiconductor Engineering program prepares students to work in the dynamic and continuously evolving field of semiconductor technology. Semiconductor engineers are at the very heart of the process that has affected all aspects of modern technology for the last half century. They develop the materials used to manufacture devices and design circuits that are ever more complex, and they are responsible for device manufacturing, as well as testing.

The program requires 33 semester credits of graduate work, consisting of core courses, specialization courses, and electives. The curriculum features substantial choice of specialization and elective courses, thereby enabling students to tailor the program to meet their specific needs and fulfill their particular aspirations.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Students enrolled through NTU whose work schedules preclude full-time study should expect to fulfill the requirements in no more than five years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Microelectronics and Semiconductor Engineering program:

- BS degree in electrical engineering, chemical engineering, or materials science and engineering from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

A total of 33 credits is required for graduation. These credits should satisfy the following distribution requirement:

Core Curriculum (9 credits)

The core curriculum consists of three courses and enables students to develop knowledge in topics basic to the area of semiconductors and microelectronics.

Each student should complete the core courses prior to pursuing specialization and elective courses.

Specializations (18 credits)

Each student selects at least six courses from an area of specialization that represents the technical emphasis most compatible with the student's educational or career goals. Areas of specialization include integrated circuits, packaging, processing and fabrication, and semiconductor and device physics; other areas may also be available. Please consult an advisor or visit the NTU Web site for information about current specialization areas and courses available in those areas.

Electives (6 credits)

Students select two additional courses from the NTU graduate catalog to meet the elective requirement and bring their total credits to a minimum of 30. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to select appropriate elective courses.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary

for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following list of courses illustrates the choice of academic material available to students who want to obtain an MS in Microelectronics and Semiconductor Engineering. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Core Courses (9 credits)

Students must take the following three courses to satisfy the core requirement:

IC 510	Introduction to Semiconductors
IC 520	Integrated Circuit Devices
IC 730	Advanced Microelectronic Processing

Specialization Courses (18 credits)

Students select six courses from one specialization to satisfy this requirement. A choice of courses for several specializations is listed below. Please consult an advisor or visit the NTU Web site for information about other specializations and courses that may be available.

Integrated Circuits

IC 541	Introduction to Digital Integrated Circuits
IC 742	Advanced Digital Integrated Circuits
IC 520	Linear Integrated Circuits
IC 771	Advanced Analog Integrated Circuits
IC 752	Computer-Aided Engineering for Integrated Circuits
IC 776	Analysis and Design of VLSI-Analog-Digital Interface Integrated Circuits
DS 710	Digital Hardware Synthesis
DS 765	Digital System Design with Hardware Description Languages
DS 766	Digital System Design and Interfacing with Verilog
DS 770	Testing and Diagnosis of VLSI Systems
IC 534	Microelectronics Test Engineering

Packaging

IC 500	Design of Electronic Packaging
IC 503	Microelectronic Packaging Materials
IC 506	Microelectronic Reliability
IC 535	Microelectronics Failure Analysis
IC 701	Electronic Packaging Principles
IC 702	Electronic Packaging Design

Processing and Fabrication

EP 725	Materials Science and Processing of Semiconductor Devices
IC 506	Microelectronic Reliability
IC 535	Microelectronics Failure Analysis

IC 714	Semiconductor Material and Device Characterization
IC 792	Introduction to MEMS Design
MS 735	Defects in Materials
IC 730	Semiconductor Device Design and Analysis
IC 531	Microelectronics Test Engineering
IC 532	Vacuum Systems Engineering
IC 734	Plasma-Assisted Materials Processing
IC 736	Thin Film Physical Vapor Deposition
EP 724	Synthesis and Characterization of Electronic Materials
EP 741	Defects, Diffusion, and Ion Implantation in Semiconductors

Semiconductors and Device Physics

IC 714	Semiconductor Material and Device Characterization
IC 721	Semiconductor Device Theory I
IC 722	Semiconductor Device Theory II
IC 724	Solid-State Devices
IC 715	Solid-State Optics
IC 717	Semiconductor Lasers and LEDs
IC 721	Fundamentals of Solid-State Electronics II
IC 727	Numerical Semiconductor Device Modeling

Elective Courses (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge

MS in Software Engineering

Software engineering is the application of engineering design principles to the development of software. It includes the design, testing, implementation, and maintenance of software.

The Master of Science in Software Engineering requires 33 credits of graduate work, consisting of four core courses, five specialization courses, and two elective courses. The curriculum features substantial choice of specialization and elective courses, thereby enabling students to tailor the program to meet their specific needs and fulfill their particular aspirations. The advanced portion of the curriculum remains open-ended, to encourage students to take advantage of new courses that concentrate on the latest developments in the field.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU, whose work schedules preclude full-time study, should expect to fulfill the requirements in five years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Software Engineering program:

- BS degree in computer science or computer engineering or a BS degree in an ABET-accredited engineering program with a minor in computing systems.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.
- Evidence of knowledge of the key topic materials relevant to the program.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 33 credits for graduation. These courses must satisfy the following distribution requirement: four core courses, five specialization courses, and two elective courses.

Core Curriculum (12 credits)

The core curriculum consists of four courses and allows students to develop knowledge across a broad spectrum of topics related to computer engineering. Students select courses from a specified set of courses covering software engineering processes, software specification, analysis and design, testing, and project management. Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (15 credits)

Students select at least five courses from an area of specialization that represents the technical emphasis most compatible with their educational and career goals. Areas of specialization for Software Engineering include architecture and design, programming and implementation, testing and reliability, and software management. Students should consult an advisor or visit the NTU Web site for information about currently offered specialization areas and courses available in those areas.

Electives (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses to meet the elective requirement and to bring their total credits to a minimum of 33. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to select appropriate elective courses.

Thesis Option

Most students are expected to pursue a non-thesis Master of Science degree program. However, when desirable and appropriate, as determined by the student in consultation with his or her academic NTU advisor, a thesis option, constituting a maximum of six credits, is available and may be substituted for the elective courses. For additional information about the thesis option and guidelines, see the Academic Information section of this bulletin.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing

duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

The following list of courses illustrates the choice of academic material available to students wishing to obtain an MS in Software Engineering. Individual course descriptions may be found on the NTU Web site at www.ntu.edu. Specific courses and course requirements may change. Updates will be posted on the NTU Web site.

Core Courses (12 credits)

Students must select four of the following courses to satisfy the core requirement:

SE 710	Software Engineering
SE 730	Object-Oriented Analysis and Design
SE 750	Software Testing and Verification
SE 770	Software Specification
SE 780	Software Project, Process, and Quality Management
CS 550	Information Systems
CS 740	Operating Systems Principles

Specialization Courses (15 credits)

Students select five courses from one specialization area to satisfy this requirement. Courses for several specialization areas are listed below. Students should consult an advisor or visit the NTU Web site for information about other specialization areas and courses available in those areas.

Architecture and Design

SE 720	Software Measurement
SE 725	Advanced Topics in Software Engineering
SE 735	Design of Interface Systems
SE 746	Embedded Systems Software Development
SE 762	Software Metrics and Quality Engineering
SE 767	Software Performance Engineering
CS 720	Programming Language Principles
CS 755	Distributed Database Design
CS 760	Client/Server Computing
CS 765	Distributed Computing Systems
CS 780	Advanced WWW Technologies
ST 720	Realtime Systems Analysis and Design
ST 760	Information System Security

Programming and Implementation

SE 531	Advanced Java Programming
SE 538	XML, Java, and the Enterprise
SE 540	Java Distributed Enterprise Computing
SE 720	Software Measurement

SE 725	Advanced Topics in Software Engineering
SE 736	Enterprise Software Development
SE 746	Embedded Systems Software Development
SE 752	Software Reliability and Safety
SE 754	Object Oriented Testing and Reliability
SE 760	Software Quality Assurance
SE 762	Software Metrics and Quality Engineering
SE 767	Software Performance Engineering
CS 720	Programming Language Principles
CS 760	Client/Server Computing
CS 780	Advanced WWW Technologies
ST 760	Information System Security

Testing and Reliability

SE 555	Software Engineering: Analysis and Evaluation
SE 725	Advanced Topics in Software Engineering
SE 746	Embedded Systems Software Development
SE 752	Software Reliability and Safety
SE 754	Object-Oriented Testing and Reliability
SE 760	Software Quality Assurance
SE 762	Software Metrics and Quality Engineering
SE 767	Software Performance Engineering
ST 760	Information System Security

Software Management

SE 760	Software Quality Assurance
SE 762	Software Metrics and Quality Engineering
SE 770	Software Specification
SE 785	Software Management and Economics
SE 786	Business Process Innovation
SE 787	Management of Computer and Information Systems
SE 792	Software Acquisition Practices, Legal and Economic Issues

Elective Courses (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

Foundation Courses

Foundation courses are available for those students who do not have an adequate preparation to begin a master's program in Software Engineering. Undergraduate Foundation courses for students entering graduate study in Software Engineering are available in the topical areas given below. Foundation courses cannot be taken for graduate credit. Please see the NTU Web site for a current set of Foundation courses.

AD 310-319	Data Structures (formerly BC 30-39 Data Structures)
CA 310-319	Computer Architecture (formerly BC 60-69 Digital System Design—Computer Architecture)
CA 360-369	Microcomputers and Embedded Computer Systems (formerly BC 40-49 Microprocessors and Assembly Level Programming)

- CM 310-319 Mathematical Logic and Automata Theory
(formerly BC 80-89 Discrete Structures)
- CS 340-349 Operating Systems (formerly BC 50-59
Operating System Principles)
- DS 360-369 Digital Hardware Design (formerly BC 20-29
Digital Logic Design)
- SE 330-339 Analysis and Design Techniques (formerly BC
10-19 Fundamentals of Computer Engineering)

MS in Systems Engineering

Systems Engineering represents an interdisciplinary approach to sound system design. It differs from other branches of engineering in that it deals with methods for analysis, synthesis, and design of complex multidisciplinary problems as opposed to solving specific disciplinary problems. Systems engineers in the 21st century can be found in many traditional engineering fields such as communications, aerospace, defense, manufacturing, and information technology, as well as nontraditional fields such as transportation logistics, medical devices, agriculture, and even criminal justice. The processes and tools enable engineers to define and validate system requirements, develop effective designs, and ensure that those designs are safe and meet customer requirements.

NTU's Systems Engineering master's degree program is designed to enable engineers from various disciplinary backgrounds to either focus completely on systems engineering or pursue a systems engineering approach from within a specific engineering discipline perspective.

Completion of the curriculum will take approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU, whose work schedules preclude full-time study, can expect to fulfill the requirements within five years by registering for at least two three-credit courses each academic year.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Systems Engineering program:

- BS degree in an engineering discipline from an ABET-accredited engineering program in the United States or a CEAB-accredited program in Canada; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 2.9 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional

admission status see the Admission section of this bulletin.

Curriculum Overview

Students must complete a minimum of 33 credits for graduation. Students will complete five core courses, four specialization courses, and two elective courses.

Core Curriculum (15 credits)

Five courses comprise the Systems Engineering core and provide a foundation in systems concepts and methods. Students will complete courses in the following topic areas:

- Accounting and Finance
- Systems Engineering Principles and Processes
- Systems Management
- Systems Modeling, Analysis, and Optimization
- Systems Reliability

Students should complete the core courses prior to pursuing specialization and elective courses.

Specializations (12 credits)

Beyond the core curriculum, students pursue specializations, completing four courses identified by NTU as appropriate to provide depth in a particular area of specialization. Specializations include the following:

- Information Systems
- Software Systems
- Systems Engineering
- Systems Engineering Management
- Systems Quality and Reliability
- Telecommunication Systems

Electives (6 credits)

Students select two additional courses from the NTU graduate catalog to meet the elective requirement and bring their total credits to a minimum of 33. Elective credits are designed to give students the opportunity to tailor the program to their individual and organizational goals and needs. Students are encouraged to consult with an NTU advisor to confirm they have the appropriate prerequisite knowledge.

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given

term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

Specific courses and course requirements may change. Updates will be posted on the NTU Web site.

Core Courses (15 credits)

Students must take the following courses to satisfy the core requirement:

SY 710	The Systems Engineering Process
SY 720	Systems Engineering and Analysis
SY 560	Systems Engineering Management
NB 750	Accounting and Finance—Measurement and Flow Control for the Economic Engine

Students complete their core courses by selecting one of the following:

SY 540	Systems Optimization and Analysis
SY 750	Systems Reliability Engineering

Specialization Courses (12 credits)

Students select four courses from one specialization area to satisfy this requirement:

Information Systems

This specialization provides students with the opportunity to focus on information systems management.

TO 710	Information Systems
TO 711	Information Systems Principles
TO 712	eCommerce Technologies
MG 750	Management Information Systems
CS 750	Database Management Systems
SE 786	Business Process Innovation
SE 787	Management of Computer and Information Systems

Software Systems

This specialization provides students with the opportunity to focus on software development and management.

SE 710	Software Engineering
SE 512	Software Systems Engineering: An Enterprise Architecture Approach
SE 780	Evaluation of Information Systems
SE 786	Business Process Innovation
SE 787	Management of Computer and Information Systems
SE 792	Software Acquisition Practices, Legal and Economic Issues

Systems Engineering

This specialization provides students with the opportunity to focus on systems concepts, methods, and tools more in depth.

SY 711	Model-Based System Design
SY 521	Systems Analysis Methods
SY 562	Systems Integration and Test
SY 563	Integrated Risk Management
SY 570	Logistics Systems Engineering
SY 580	Systems Engineering Design

Systems Engineering Management

This specialization provides students with the opportunity to emphasize management.

SY 562	Systems Integration and Test
SY 563	Integrated Risk Management
MB 710	Introduction to Engineering Management
NB 721	Leadership and Teamwork—Accomplishing Momentum Transfer Using Authority, Power, and Influence
NB 720	Organizational Behavior—Working Within the Equations of State
TO 760	Introduction to Project Management
NB 710	Technology and Operations—Moore's Law and Other Business Accelerators
TO 580	Production and Operations Management

Systems Quality and Reliability

This specialization provides students with the opportunity to focus on quality management and improvement, statistical methods, systems testing, and reliability.

SY 562	Systems Integration and Test
TO 771	Reliability Engineering
TO 750	Total Quality Management
TO 751	Methods for Quality Improvement
MA 520	Probability and Statistics for Engineers
MA 731	Design and Statistical Analysis of Experiments for Engineers

Telecommunications Systems

This specialization provides students with the opportunity to focus on telecommunication and communication networks and management.

CC 786	Principles of Broadband ISDN and ATM
TC 502	Introduction to Telecommunications
TC 721	Data Communications I
TC 725	Internet Communications Using SIP
TC 745	Wireless Networks
TC 774	Management of Telecommunications

Elective Courses (6 credits)

Students may select their two elective courses from any of NTU's graduate-level courses, provided they have the appropriate prerequisite knowledge.

MS (Special Majors)

The NTU Special Majors program is designed to fill the needs of students with fields of interest that go beyond the existing NTU degree programs. Within specified specialty areas, students may pursue a program of study that enables them to earn a specialized master's degree.

The Master of Science (Special Majors) program consists of 36 credits chosen from core, specialization, and elective areas. The core and specialization credits form a coherent and acceptable collection of courses that provide students with a firm understanding of their chosen area of concentration. The elective courses may be selected from any of the graduate-level courses offered in the NTU catalog.

Completion of the curriculum requires approximately one-and-a-half years of full-time graduate study. Part-time students enrolled through NTU should expect to fulfill the requirements in three to six years, depending on the course load.

Admissions Requirements

Students must meet the following eligibility requirements for regular admission into the Special Majors program:

- BS degree in an appropriate accredited science or engineering program from a U.S. institution; or the equivalent from a foreign institution.
- Cumulative undergraduate G.P.A. of at least 3.0 on a 4.0 scale.

Students who do not meet these requirements may be granted provisional admission into the program, depending on academic background and experience. For additional information about provisional admission status, see the Admission section of this bulletin.

Curriculum

Students must complete a minimum of 36 credits for the Special Majors program, consisting of three core courses, seven specialization courses, and two elective courses.

Specializations

Specializations available in the Special Majors degree program include Telecommunications Management, Optics, Information Systems

Engineering, and Technical Management. A complete list can be found on NTU's Web site under the Special Majors program description.

The following sample specialization programs illustrate the flexibility available to students under the Special Majors program. *Specific courses and course requirements may change. Updates will be posted on the NTU Web site.*

Telecommunications/Telecommunications Management Specialization

Course No.	Example Title	Credits
Core Courses (9 credits)		
TC 502	Introduction to Telecommunications Systems	3
TC 721	Data Communications 1	3
TC 751	Wireless, Cellular, and Personal Telecommunications	3
Specialization Courses (21 credits)		
TC 770	Telecommunications Analysis, Planning, and Design	3
TC 774	Management of Telecommunications	3
TC 775	Wireless Management	3
TC 583	Telecommunications Management and Regulations	3
TC 796	Switching and QoS Management in IP Networks	3
MG 770	Legal and Policy Issues in Business	3
MG 723	Supply Chain Management	3
Suggested Elective Courses (6 Credits)—Choose 2		
TC 745	Wireless Networks	3
TC 725	Internet Communications Using SIP	3
QM 710	Operations Research Models	3
MG 720	Marketing Management	3
TO 568	Project Estimating and Cost Management	3

Technical Management Specialization

Course No.	Example Title	Credits
Core Courses (9 credits)		
EF 715	Accounting and Finance for Engineers	3
EF 735	Economic Decision Analysis	3
TO 760	Introduction to Project Management	3
Specialization Courses (21 credits)—Choose 7		
EF 710	Engineering Accounting	3
EF 720	Engineering Finance	3
QM 710	Operations Research Models	3
TO 750	Total Quality Management	3
TO 751	Total Quality Improvement	3
TO 761	Advanced Project Management	3

TO 764	Risk Management	3
TO 568	Project Estimating and Cost Management	3
TO 770	Statistical Methods for Quality and Productivity Improvements	3
TO 771	Reliability Engineering	3

Suggested Elective Courses (6 Credits)—Choose 2

MG 720	Marketing Management	3
MG 723	Supply Chain Management	3
MG 770	Legal and Policy Issues in Business	3

Optics Specialization

Course No.	Example Title	Credits
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Core Courses (9 credits)

EM 711	Introduction to Fourier Optics	3
EM 513	Fiber Communications and Systems	3
EM 716	Optical Design and Instrumentation	3

Specialization Courses (21 credits)

CC 510	Introduction to Communications and Signal Processing	3
EM 714	Advanced Fiber Optics	3
EM 715	Optical Detectors and Detector Systems	3
EM 718	Diffraction and Interferometry	3
EM 722	Integrated Optics	3
EM 740	Electromagnetic Theory	3
TC 512	Fiber Optic Telecommunications	3

Suggested Elective Courses (6 Credits)—Choose 2

EM 735	Microwave and RF Wireless Systems	3
EM 736	Active Microwave Circuits	3
EM 721	Introduction to Lasers	3

Information Systems Management Specialization

Course No.	Example Title	Credits
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Core Courses (9 credits)

TO 710	Information Systems	3
CS 750	Database Management Systems	3
SE 787	Management of Computer and Information Systems	3

Specialization Courses (21 credits)—Choose 7

CS 760	Client/Server Computing	3
MG 750	Management Information Systems	3
SE 512	Software Systems Engineering: An Enterprise Architecture Approach	3
SE 786	Business Process Innovation	3
TC 721	Data Communications I	3
CS 550	Information Systems	3
CS 755	Distributed Database Design	3
EF 735	Economic Decision Analysis	3

Suggested Elective Courses (6 Credits)—Choose 2

ST 760	Information System Security	3
CS 740	Operating Systems Principles	3
CS 758	Datamining	3
SE 710	Software Engineering	3

Program of Study Plan

Admitted students should submit a Program of Study Plan (PSP) to NTU prior to completion of six semester credit hours. Failure to submit a PSP increases the possibility of students completing duplicate courses or courses that are not applicable to their degree programs. Although NTU cannot guarantee preferred course availability in any given term, the PSP documents do guide course selection from partner universities. It may be necessary for a student to revise an approved PSP when course availability does not comply with the student's needs. The PSP form should be submitted through the NTU Web site.

Undergraduate Foundation Courses

National Technological University offers many Foundation courses that enable students to prepare for successful graduate study. Foundation courses are 300-level NTU courses that do not carry graduate credit. In cases where students do not have undergraduate degrees that are appropriate preparation for the degrees they seek, they work with NTU to develop a sequence of Foundation courses that will provide them with the necessary background. In other cases, NTU may require some Foundation coursework to help students update their undergraduate technical competence.

General Foundation Areas

MA 320-339	Probability and Statistics (formerly BR 00-09 Mathematics)
MA 340-349	Calculus/Complex Variables/Vector and Matrix Analysis (formerly BR 00-09 Mathematics)
MA 360-369	Algebra (formerly BR 00-09 Mathematics)
MA 380-389	Differential Equations (formerly BR 00-09 Mathematics)
MC 310-319	General Materials (formerly BR 40-49 Materials Science and Engineering and BR 50-59 Mechanical Engineering with the exception of BR 347-Q)
ME 310-319	Mechanics, Dynamics, and Vibrations (formerly BR 00-09 Mathematics)
ME 325	Design (formerly BR 347-Q)

Computer Engineering, Computer Science, and Software Engineering

Applications of computers are pervasive today, affecting the work of most engineers and technical professionals. It is natural, therefore, for people with very diverse technical backgrounds to seek additional education in computing. For that reason, NTU faculty members have precisely identified the undergraduate prerequisites that are the necessary preparation for entering graduate study in computer engineering, computer science, and software engineering. This information is intended to serve as a guide to potential registrants in graduate-level courses, so they can verify that they have the fundamental knowledge that most instructors will expect them to have. NTU does not offer all of these types of courses. For more information about choosing the appropriate courses at local institutions, students should visit the NTU Web site.

AD 310-319	Data Structures (formerly BC 30-39 Data Structures)
CA 310-319	Computer Architecture (formerly BC 60-69 Digital System Design—Computer Architecture)
CA 360-369	Microcomputers and Embedded Computer Systems (formerly BC 40-49 Microprocessors and Assembly Level Programming)
CM 310-319	Mathematical Logic and Automata Theory (formerly BC 80-89 Discrete Structures)
CS 340-349	Operating Systems (formerly BC 50-59 Operating System Principles)
DS 360-369	Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
SE 330-339	Analysis and Design Techniques (formerly BC 10-19 Fundamentals of Computer Engineering)

Electrical Engineering

Admission to the MS in Electrical Engineering program requires a BS degree in electrical engineering. The crucial components of this preparation are the following: two one-semester courses in circuits, one in electronics, one in systems, one in electromagnetics, and one in digital design; plus some proficiency in computer programming.

Applicants seeking the MS in Electrical Engineering who do not have a BSEE degree can prepare themselves by taking the following Foundation courses, by taking equivalent courses at a local institution, or by establishing equivalencies of courses taken in another degree program.

CC 310-319	Communications Systems (formerly BE 40-49 Systems)
CR 310-319	General Circuit Theory (formerly BE 10-19 Circuits)
DS 360-369	Digital Hardware Design (formerly BC 20-29 Digital Logic Design)
EM 340-349	Electromagnetic Field Theory (formerly BE 30-39 Electromagnetics)
IC 320-329	Electronic Devices and Modeling (formerly BE 20-29 Electronics)
PS 330-339	Energy Conversion (formerly BE 50-59 Systems)

Other Foundation Areas

Students may also need to take courses through local colleges, if the coursework they need is not offered by NTU. Advice about Foundation courses is available from NTU advisors. Students are encouraged to work with NTU advisors prior to enrolling in Foundation courses. Other Foundation areas may include:

Chemistry (formerly BR 20-29)
Engineering Science (formerly BR 30-39)
Interfacing and Computer Networks (formerly BC 70-79)
Physics (formerly BR 10-19)
Special Topics (formerly BR 90-99)

Fast Track Certificate Program in Computer Science

NTU offers an accelerated academic program of six undergraduate computer science courses designed to help students stay on track in their careers. The Fast Track program provides focused, in-depth courses that offer core computer science knowledge to help students transition into computer science or software engineering fields.

Instructors have condensed course materials to specifically meet the needs of students working in high-tech fields. Each course is 1.6 credits and is offered for audit or pass/fail only. Course notes are provided, as well as optional homework assignments and exams. A teaching assistant is available via email and phone to answer questions and help with assignments.

Fast Track Courses

FT 001-NT Computer Organization
FT 002-NT Algorithms and Data Structures
FT 003-NT Computer Programming Languages
FT 004-NT Foundations of Computer Sciences: Formal Languages and Automata
FT 005-NT Software Engineering
FT 006-NT Operating Systems

NTU does not grant academic credit for these courses, but successful completion will enable a student with an unrelated bachelor's degree to better prepare for graduate-level coursework in NTU's Computer Science or Software Engineering master's programs. Students are not required to take all six courses, but students who complete the six-course series will earn a Certificate of Completion in Principles of Computer Science.

Certificate Programs

In the rapidly evolving world of engineering and computer technology, expanding knowledge is critical to future effectiveness and career advancement. NTU has several master's-level certificates designed for working professionals who want to develop their knowledge and skills in focused areas of graduate study. Each certificate consists of three to five graduate courses.

Typically, students can complete a graduate certificate in as little as one year. Most will easily complete these programs within two years. The graduate credits earned as part of the certificate program can also be applied toward a master's degree program, should a student want to continue with their studies. Successful completion of a master's-level certificate does not automatically translate into full NTU graduate admission: admissions requirements for the master's program still need to be met.

NTU maintains a current list of master's-level certificates on its Web site. Since 2003, NTU has launched several graduate certificates, described briefly here and in more depth at www.ntu.edu.

Graduate Certificates

Application Procedure

Students interested in Graduate Certificate programs should go to the "Certificate Programs" link at www.ntu.edu to obtain current information about certificate programs. To apply, students should click the "Apply Now" link and follow the procedures outlined on the resulting screens. General information about registration may also be obtained by emailing registration@ntu.edu.

Upon meeting the requirements for a certificate, a student should submit an electronic request for a certificate, indicating courses taken and grades received. NTU will verify the information and issue certificates quarterly (February, May, August, and November). An entry will be made on the student's transcript, and the certificate will be sent to the student's home address.

Requirements

To receive a certificate, students must fulfill the following requirements:

- Complete the required NTU graduate courses for the certificate.

- Receive a *B* or better in each course. (A grade of *B-* cannot be counted toward a certificate.)

Master's-Level Certificates

NTU maintains a current list of available certificates on its Web site at www.ntu.edu. Listed below are some of the master's-level certificates and their required courses:

Durability and Reliability in Design

- TO 771-E Reliability Engineering
- ME 521-U Finite Element Fundamentals with Applications
- ME 714-U Advanced Machine Design

One of the following courses:

- ME 582-Q Failure Mechanisms in Engineering Materials
- ME 583-Q Failure Analysis of Mechanical Components
- MP 730-CU Fracture Mechanics

Project Management

- TO 760-CU Project Management Systems
- TO 761-CU Advanced Topics in Project Management
- EF 710-NJ Concepts of Strategic Cost Analysis
- SY 563-N Integrated Risk Management

Systems Engineering

- SY 560-N Systems Engineering Management
- SY 710-E The Systems Engineering Process
- SY 711-E Model-Based System Design

One of the following courses:

- SY 721-U Applied Systems Engineering
- SY 750-N Systems Reliability Engineering
- SY 562-N Systems Integration and Test

Microelectronics Packaging

- IC 701-E Electronic Packaging Principles
- IC 702-E Electronic Packaging Design
- IC 503-E Microelectronic Packaging Materials

One of the following courses:

- IC 506-NM Microelectronic Reliability
- IC 535-NM Microelectronic Failure Analysis

Software Project Management

Four of the following courses:

- SE 762-N Software Measurement and Quality Engineering
- SE 770-R Software Specification
- SE 555-A Software Engineering: Analysis and Evaluation
- SE 584-N Software Project Planning and Management
- SE 785-SC Software Management and Economics

Telecommunications Management

- TC 770-OB Telecommunication Analysis, Planning, and Design
- TC 774-NJ Management of Telecommunications
- TC 583-N Telecommunications Management and Regulation

One of the following courses:

- TC 502-N Introduction to Telecommunications
- TC 747-N Telecommunications Network Management
- TC 775-N Wireless Management and Convergence

Object-Oriented Programming

- SE 531-N Advanced Java Programming
- SE 730-D Object-Oriented Analysis and Design
- SE 754-NT Object-Oriented Testing and Reliability
- SE 540-N Java Distributed Enterprise Computing

Certificates of Completion

In addition to the pre-configured certificates above, NTU offers a Certificate of Completion program that allows students, in concert with their advisors, to configure their own course sequences. The NTU Certificate of Completion program is designed to recognize the achievements of students whose courses meet specific needs of their individual careers. This program is especially beneficial to those who already have a master's or doctoral degree and do not want to pursue another advanced degree. It provides recognition of academic accomplishment while upgrading technical competence or reorienting professional careers. Students who satisfy the requirements receive a Certificate of Completion and a permanent record on their NTU transcript.

Students may take advantage of this program to earn one or more Certificates of Completion. A course may be used only once for certificate purposes; however, the same course may also be applied toward a master's degree. Foundation courses are not accepted for a certificate.

Application Procedure

Students interested in a Certificate of Completion program should contact an NTU advisor (advisor@ntu.edu). Students will be asked to submit a brief proposal describing their specific needs for a certificate, listing the set of courses they intend to use toward the certificate, and explaining how those courses form a coherent program that addresses their needs.

Upon meeting the requirements for a certificate, a student should submit an electronic request for a certificate, indicating courses taken and grades

received. NTU will verify the information and issue certificates quarterly (February, May, August, and November). An entry will be made on the student's transcript, and the certificate will be sent to the student's home address.

Requirements

To receive a certificate, students must fulfill the following requirements:

- Complete at least four NTU graduate courses for a minimum of 10 semester credits.
 - Three courses in one specific area of specialization (e.g., AD, CA, ME, or a sub-area of these.)
 - One additional course in the same area or in a supportive area of specialization.
- Receive a *B* or better in each course. (A grade of *B-* cannot be counted toward a certificate.)

Specialty Areas

The following is a list of the specialization-area designations that are available through NTU:

AD	Algorithms and Data Structures
AE	Aerospace Engineering
CA	Computer Architecture
CC	Communications
CH	Chemical Engineering
CM	Computational Methods and Theory
CR	Circuit Theory
CS	Computer Software
CT	Control Theory
DS	Digital Systems
EA	Emerging Areas
EF	Economics and Finance
EM	Electromagnetics
EP	Electrical Properties
ES	Engineering Science
EV	Environmental Systems Management
IC	Integrated Circuits
IS	Intelligent Systems
MA	Mathematics
MB	Management and Behavioral Science
MC	Materials Characterization
ME	Mechanical Engineering
MG	Business and Administration
MP	Mechanical Properties
MS	Materials Science
NB	MBA Core Subject Areas
PD	Product and Process Design
PM	Polymeric Materials
PS	Power Systems
QM	Quantitative Methods
SE	Software Engineering
SP	Manufacturing Systems Planning and Control
ST	Software Techniques
SY	Systems Engineering

TC Telecommunications
TO Technical Operations

FT 005-NT Software Engineering
FT 006-NT Operating Systems

Sample Certificate of Completion Programs

Listed below are some sample course choices for Certificate of Completion programs:

Computer Architecture

CA 720 Digital Computer Design
CA 726 VLSI Architecture
CA 760 Embedded Computer Systems
CT 712 Linear Systems Theory

Semiconductor Engineering

IC 701 Electronic Packaging Principles
IC 506 Microelectronic Reliability
IC 724 Solid-State Devices
IC 730 Advanced Microelectronic Processing

Software Engineering

SE 742 Software Generation and Maintenance
SE 750 Software Testing and Verification
SE 770 Software Specification
SE 783 Software Management

Quality Control and Reliability

TO 570 Industrial Quality Control
TO 771 Reliability Engineering
TO 772 Maintainability Engineering
TO 775 Advanced Management of Quality

NTU does not grant academic credit for these courses, but successful completion will enable a student with an unrelated bachelor's degree to better prepare for graduate-level coursework in NTU's Computer Science or Software Engineering master's programs. Students are not required to take all six courses, but students who complete the six-course series will earn a Certificate of Completion in Principles of Computer Science.

Fast Track Certificate Program in Computer Science

NTU offers an accelerated academic program of six undergraduate computer science courses designed to help students stay on track in their careers. The Fast Track program provides focused, in-depth courses that offer core computer science knowledge to help students transition into computer science or software engineering.

Instructors have condensed course material to specifically meet the needs of students working in high-tech fields. Each course is 1.6 credits and is offered for audit or pass/fail only. Course notes are provided as well as optional homework assignments and exams. A teaching assistant is available via email and phone to answer questions and help with assignments.

Fast Track Courses

FT 001-NT Computer Organization
FT 002-NT Algorithms and Data Structures
FT 003-NT Computer Programming Languages
FT 004-NT Foundations of Computer Sciences: Formal Languages and Automata

University Administration

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