

Electrical and Computer Engineering

Undergraduate Handbook



Binghamton University
State University of New York

Thomas J. Watson School of Engineering and Applied Science

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ELECTRICAL AND COMPUTER ENGINEERING UNDERGRADUATE HANDBOOK

This handbook has been created to assist students and faculty members in the Electrical Engineering and Computer Engineering programs at Binghamton University. The handbook is intended to compliment the University *Bulletin*, and to specifically provide further details about University policies and procedures, as well as the Electrical Engineering and Computer Engineering undergraduate programs, and will be revised periodically to include up to date program information and policy changes. Comments and suggestions of how this handbook can be improved are always welcome. Please contact:

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It is the responsibility of the individual student to be familiar with information contained in the University Bulletin. With respect to official University policy and regulations, the University Bulletin takes precedence over any information contained in this handbook.

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I. INTRODUCTION

This handbook contains information on the Bachelor of Science degree programs in Electrical Engineering and Computer Engineering at Binghamton University. Both programs are accredited by ABET, Inc., the recognized accreditor for college and university programs in applied science, computing, engineering, and technology.

Program Objectives

Graduates of the EE and CoE programs should demonstrate progress in the following four areas:

1. **Leadership:** Graduates will be known for leadership, innovation, entrepreneurship, and responsibility as appropriate for their career stage
2. **Education:** Graduates will continue their education through a combination of independent learning, continuing education and advanced degrees.
3. **Ability:** Graduate will demonstrate ability in a career that utilizes skills and knowledge gained in their undergraduate engineering program.
4. **Participation:** Graduates will be known as active participants in a wide variety of both professional and non-professional activities, including jobs, professional societies, community activities, and government service.

Program Outcomes

The following abilities and knowledge are expected to be demonstrated by students upon time of graduation:

1. The ability to apply knowledge of mathematics, science, and engineering.
2. The ability to apply probability and statistics in electrical engineering / computer engineering applications.
3. The ability to use modern techniques, skills, and tools necessary for electrical engineering / computer engineering practice.
4. The ability to design and conduct experiments, and to analyze and interpret data.
5. The ability to analyze electronic devices and circuits, software components, and systems containing hardware and software.
6. The ability to design hardware and software components, as well as the ability to integrate these components into systems that meet required specifications.
7. The ability to identify, formulate, and solve electrical engineering / computer engineering problems.
8. The ability to function as an engineer on multi-disciplinary teams.
9. The ability to identify and discuss the professional and ethical responsibilities of an engineer.
10. The ability to communicate effectively in written and oral formats.
11. A broad education and knowledge of contemporary issues necessary to explain the impact of engineering solutions in a global and societal context.
12. A recognition of the need for, and the ability to engage in, life-long learning.

II. ELECTRICAL AND COMPUTER ENGINEERING AT BINGHAMTON UNIVERSITY

Through high-quality educational and research programs, the department serves and enriches society, advances knowledge, and prepares graduates to excel, innovate and lead.

Electrical Engineering (EE) is one of the broadest engineering disciplines. The Bachelor of Science in Electrical Engineering program covers all areas of electrical engineering and provides balance between theory and practical application. Students majoring in Electrical Engineering can choose to specialize in one of the following areas: communications and signal processing, controls, electromagnetics, electro-optics, electronic packaging, and microelectronics.

The EE curriculum provides an excellent preparation for graduate studies. For qualified undergraduates, we offer an accelerated five-year program that leads to both a BS and an MS degree in Electrical Engineering. Another five-year program leading to a BS in Electrical Engineering and an MBA (Master of Business Administration) also exists.

Computer Engineering (CoE) is one of the newer engineering disciplines. The Bachelor of Science in Computer Engineering program provides a balance between hardware and software and between theory and application. The roots of computer engineering lie in electrical engineering and are enriched by computer science. A computer engineer analyzes and designs electronic circuits and components, microprocessors and software, and integrates hardware and software into larger systems. In addition, a computer engineer may also work in information technology and be involved in a multidisciplinary team.

The CoE curriculum provides an excellent preparation for graduate studies. For qualified undergraduates, we offer an accelerated five-year program that leads to both a BS and an MS degree in Computer Engineering. Another five-year program leading to a BS in Computer Engineering and a MBA (Master of Business Administration) also exists.

The first year is common among all the engineering programs in the Watson School of Engineering and Applied Science and provides fundamentals in mathematics and science, principles that underlie all engineering disciplines, technical communication in both spoken and written forms, and courses required by the University's General Education Requirements.

In the second year, students may enter the Electrical Engineering Program or Computer Engineering Program, but the courses are common between electrical and computer engineering students; this year provides the basic set of skills and knowledge that is common between the two programs; including continuing work in science and mathematics. In addition, the Electrical and Computer Engineering Seminar I course provides students with an overview of both CoE-specific as well as

EE-specific technical areas and insights into the different levels at which electrical and computer engineers can work (e.g., device-level, circuit-level, system-level, etc.)

In the third year, EE and CoE students take most of the courses that provide a background with enough breadth to support a large variety of career paths as well as allow effective interaction with specialists in a variety of areas. These courses draw from traditional electrical and computer engineering courses. Having been exposed to a wide range of courses by the end of the third year, the students have enough familiarity with the field to select electives during their fourth year. A key feature of the third year is a second seminar course that focuses on professional issues such as typical career paths in ECE areas, engineering ethics, resume writing and job search techniques, preparing for graduate school, professional engineer license, etc. Another key feature of the junior year is the Design Lab, which ties together all areas of the engineering curriculum and provides students with experience in solving open-ended design problems with realistic specifications. In addition, students are introduced to coping with real-world design issues and constraints.

Our *Electrical Engineering* and *Computer Engineering* programs provide breath across the disciplines and a balance between theory and application. In addition, a large number of laboratory courses provide opportunities for hands-on learning. Both programs provide graduates the skills and knowledge necessary for a dynamic career in either Electrical or Computer Engineering, or a variety of other careers.

III. ACADEMIC POLICIES

The Watson School generally follows the University-wide academic policies which are all available on the Binghamton University website (<http://www.binghamton.edu>). The following policies also apply to Watson School students, who are expected to be familiar with and abide by the regulations that follow.

All matriculated students follow the requirements for graduation listed in the *Bulletin/Catalog* current at the time they are admitted. However, undergraduate students who interrupt enrollment for three or more consecutive semesters are governed by the *Bulletin/Catalog* in effect when they are readmitted.

Program Load and Planning

Students are considered full time if they are registered for *12 credit hours* or more. The maximum number of credits a Watson School student may take, without an approved petition, is *18 credits*. General academic petitions to overload are only approved for graduating seniors in good standing, or for those with a 3.0 grade-point average and no grades of Incomplete.

Watson School students may enroll for fewer than 12 credits without consent and be classified as part time. Students receiving financial aid should check with the Office of Student Financial Aid and Employment Office before becoming part time, because this action may affect aid eligibility.

Requirements for Degrees

To receive any Watson School undergraduate degree, students must satisfactorily complete at least *30 credits* of Binghamton University courses taken entirely in the Watson School. Requests for exceptions to this policy must be made by petition to the Watson School Undergraduate Studies Committee and be approved by the dean.

Students must not be under any disciplinary action at the time of graduation. They must also pay or satisfactorily adjust all fees and bills.

General Education Requirements

All newly admitted Watson School students are subject to the General Education requirements. For a complete description of Binghamton University's General Education Requirements, see page 23.

For further information, refer to the handout "*General Education and Your Watson School Major*," available in the Watson School Advising Office.

Grading System

Students who enroll in courses offered outside of Watson School undergraduate programs are graded according to the grading system of the school offering the course. Such students may petition to have the Watson School's undergraduate grading system apply.

Watson School undergraduate courses are graded in one of two ways:

- A, A-, B+, B, B-, C+, C, C-, D, F, W, or
- Pass/Fail.

Students normally choose the letter grade option. However, in certain cases, students may elect the Pass/Fail option and receive a P (Pass) or F (Fail) rather than a traditional grade.

Add/Drop Policies

Students are expected to be familiar with the University-wide policies governing changes in their course registration, specifically the add/drop deadlines. No changes are made to an undergraduate record after two years have passed.

Add Deadline: The add deadline is midnight on the Sunday immediately preceding the third week of classes.

Drop Deadline: The drop deadline is midnight on the Friday of the second week of classes.

Course Withdrawal: The course-withdrawal period extends from the drop deadline until the end of the ninth week. Students who drop courses online during this period will receive a grade of "W," which does not count toward the student's grade point average. Deadlines for summer courses and variable-credit courses are adjusted accordingly and can be completed only through the Registrar.

Note: If an academic petition is approved for a late add or late drop because of extraordinary circumstances, the Student Accounts Office imposes a late add/drop fee.

Incompletes

Instructors may temporarily submit a grade notation of Incomplete, which appears in grade reports as "I." A grade of Incomplete must be removed and replaced with a permanent grade no later than the last day of classes of the semester following the one in which it was received; however, an instructor may set an earlier date for completion of the work. If approved by the instructor, the student may request an extension using a form available from Watson Advising. If the grade is not removed

by the applicable date, and an extension has not been granted, the grade of “I” automatically becomes a grade of “F.”

Watson School Policy for Course Withdrawal after the Official University Withdrawal Deadline

Under extraordinary circumstances, a student may seek withdrawal from a course after the withdrawal deadline. This is subject to Dean’s Office approval and requires:

- A formal letter of request addressed to the Associate Dean
- Accompanying official documentation (medical reports, etc.).

Both of the above are mandatory. A request must be received by the Associate Dean for Academic Affairs and Administration no later than *72 hours* before the last day of classes in the current semester. Any request will be acted upon within two business days. If the withdrawal is approved, a form allowing a waiver of the University deadline and a “W” in the grading area will be processed with copies distributed to the Registrar, Watson School Advising, the department of major, and the student.

Academic Standing

Satisfactory Academic Progress

Students’ academic progress is reviewed at the end of each regular semester to ensure that satisfactory progress is maintained. “Satisfactory progress” is defined as maintaining a **2.0 grade-point average** (GPA). The GPA is calculated on a 4.0 system using the following grade-point equivalents:

A	=	4.0	C+	=	2.3
A–	=	3.7	C	=	2.0
B+	=	3.3	C–	=	1.7
B	=	3.0	D	=	1.0
B–	=	2.7	F	=	0.0

Repeating Courses

For undergraduates, a D grade is considered passing. However, some students are advised to retake a passed course. While students may retake a course in which a passing grade was earned, only the first passing grade counts toward degree progress, but both show on the transcript. The retaken course is not considered part of the normal 12 credits required for full-time status and it is not calculated into the grade-point average. The Degree Audit Recording System (DARS) still uses the first passing grade for a repeated course.

When a course is repeated in which the student earned a failing grade, the retaken course counts toward the rate of degree progress. The two grades are calculated into the grade-point average and both show on the student transcript.

Academic Honors

Students who complete any given semester with a **3.5 or better GPA** are placed on the Dean's Honors List. For both part- and full-time students, this honor is noted on the permanent transcript.

For graduation honors, the criteria are:

- 3.50-3.69 GPA: cum laude
- 3.70-3.84 GPA: magna cum laude
- 3.85-4.00 GPA: summa cum laude

Academic Probation and Suspension

Provisional Probation: Students whose grade-point average (GPA) for a given semester falls below 2.0 are placed on provisional probation for the following semester, as long as their cumulative grade-point average is above 2.0. Provisional probation is not listed on student transcripts.

Probation: Students who's cumulative GPA for courses taken at Binghamton falls below 2.0 are placed on academic probation for the following semester, and are subject to the following restrictions:

- They may not register for more than 14 credit hours.
- They may not campaign for or accept any campus office or committee chairmanship.

Students are removed from probation when the achieved cumulative GPA is 2.0 or above. Academic probation does not preclude students from receiving financial aid.

Suspension: Students on probation who again fail to meet both the 2.0 cumulative GPA and the last-semester GPA given in the table below are suspended. Suspension lasts for one academic semester, not including summer. If approved for readmission after a semester away, the student must maintain the minimum semester average noted below to avoid a second suspension. The credit hours attempted are those taken as a matriculated student. Students who meet the last-semester GPA requirement but still post a cumulative GPA under 2.0 remain on probation.

<i>Hours Attempted</i>	<i>Last Semester GPA</i>
0-16	2.0
17-32	2.1
33-48	2.1
49-64	2.2
65+	2.3

Dismissal: Students who, after being suspended and readmitted twice, again fail to meet the required academic standards are dismissed. The academic affairs committee will hear a single appeal of dismissal after demonstration of significant changes. Appeals of decisions of the academic affairs committee are referred to the dean.

For the purpose of determining academic standing, credits earned prior to matriculation in Watson School may be reviewed.

Withdrawal and Readmission

Undergraduate students who withdraw from the Watson School during any semester and wish to remain in good standing must follow a formal withdrawal procedure. Mere absence from class does not constitute withdrawal. Withdrawal forms may be obtained from the Watson School Advising Office or the Registrar's Office, either in person or through the mail. A grade of W is assigned when the student has withdrawn from all courses and thus from the University. Grades of W do not count as courses taken.

The Watson School applies the same withdrawal and readmission policies as established for the University, except that Watson School students may drop below a 12-credit program without permission.

Undergraduate students must apply for readmission through the Undergraduate Admissions Office if they have not been in attendance for one or more semesters. Readmission forms are available on the Binghamton University website or by phone request to the Office of Undergraduate Admissions.

Students who interrupt enrollment for three or more consecutive semesters are governed by the *Bulletin* in effect when they are readmitted. Summer sessions and the semester when a student officially withdraws are not included in this count. Exceptions are made for students eligible to continue at Binghamton who are forced to leave because of involuntary call to military service.

Student Monitoring (DARS)

In addition to meeting all University and Program requirements, a student must maintain a minimum 2.0 cumulative GPA, as well as a 2.0 GPA in their major. Each student's progress toward degree completion is monitored continually by a ***Degree Audit Reporting System*** (DARS) report. This DARS Report shows:

- All courses required for degree completion, including Binghamton University general education requirements, with notations indicating if a requirement is fulfilled, in progress, or completed;
- The student's cumulative GPA for all courses used toward degree requirements;
- The student's GPA in their major requirements;
- Transfer courses that have been used to fulfill degree requirements; and
- Exceptions or substitutions that have been approved by the Electrical and Computer Engineering Undergraduate Program Director or the ECE Department Chair.
- 32 required degree credits of math and science as mandated by ABET.

Students can access their DARS report through the Binghamton University BU Brain Portal. Using their PODS user name and password to access the portal they proceed to the Records Access tab then click on the Banner DARS link where they can view and print their DARS. They are required to bring a printed copy when meeting with a faculty adviser. Questions or problems with that degree audit report can be addressed with the student's faculty advisor, ECE Undergraduate Program Director, and/or Representatives of the Watson Advising Office.

See **Appendix: Commonly Used Forms** for a sample DARS Report.

Any student requesting a deviation from specific degree requirements must gain department approval on a *DARS Exception Form*. Signed forms are processed by the Watson Advising Office and returned to the department for the individual student's file. Once processed, the exception appears on any future DARS report.

See **Appendix: Commonly Used Forms** for a sample DARS Exception Form.

At the beginning of each semester the Registrar's Office mails *DARS Graduation Check* forms to each student who filed the *Application for Undergraduate Degree* form for that semester, with duplicate copies sent directly to the Watson Advising Office. This allows time for intended graduates to verify that their final semester schedule will satisfy outstanding program requirements.

See Appendix: **Commonly Used Forms** for a sample DARS Graduation Check.

Academic actions (suspension, probation, honors) are completed by the Watson Advising Office at the end of each semester, with letters signed and reviewed by the Dean's Office.

IV. UNDERGRADUATE ADMISSIONS

The application procedure for the Watson School's undergraduate programs is essentially the same as for admission to Binghamton University. Students wishing to take courses for credit or pursue degree programs in Harpur College of Arts and Sciences, College of Community and Public Affairs, Decker School of Nursing, School of Education, School of Management or Thomas J. Watson School of Engineering and Applied Science must be admitted to the specific school before registering for courses. Forms and information are available in the Undergraduate Admissions Office and on the Web.

Academic Integrity

Binghamton University values honesty and integrity. Students applying for admission or readmission must provide full and accurate information on the appropriate application. Students falsifying information by any method may be suspended or dismissed from the University or have their admission rescinded.

Freshmen Admission

Freshmen are defined as students who have attempted no college coursework, or whose only college courses were pursued before high school graduation. All of Binghamton's undergraduate schools accept freshman applicants. Applications are available on the Web at <http://www.binghamton.edu>, from the State University of New York application processing center or from any high school guidance office in New York State.

Non-residents should send their applications directly to Binghamton's Office of Undergraduate Admissions. Those choosing to use the Common Application should follow the directions provided on the Common Application website.

Binghamton also requests that candidates submit a Supplementary Admission Form that provides additional information about course-work, extra-curricular activities, awards, and other experiences. An essay and a teacher or counselor recommendation are also required. Results of the Scholastic Assessment Test or American College Testing Program *must be sent directly by the testing agency to the Admissions Office*. Binghamton requires all three parts of the SAT examination: math, critical reading and writing. Applicants must be graduates of an accredited secondary school or offer evidence of equivalent education.

In addition to the high school transcript, freshmen who have taken courses for college credit should have a record of that work sent by the college or testing agency directly to the Admissions Office.

After admission for the fall term has been offered, a \$150 tuition deposit must be paid by May 1, or 20 days after admission, as specified in the admission letter. Students applying for campus housing must pay an additional \$200 by May 1, or 20 days after admission, as specified. The tuition and room deposits may be refunded

only if requested before May 1 or 20 days after admission, whichever is later. Students admitted to the spring term are given 20 days to pay each deposit or until the start of the term, if less than 20 days.

All enrolling students must complete, with the aid of a health official, a health history and a physical examination report prior to registration. Students unable to submit health forms because of religious affiliation should consult the University Health Service for alternatives.

How Freshman Admission Decisions are Made

Specific enrollment goals are set for each undergraduate school. Supply and demand (available spaces in relation to the number of applications), as well as admission policy, play a role in who is admitted. Admission is very selective. Freshmen are admitted to all undergraduate programs in Harpur College of Arts and Sciences, College of Community and Public Affairs, Decker School of Nursing, School of Education, School of Management and Thomas J. Watson School of Engineering and Applied Science. Admission decisions are announced on a modified rolling basis, with the first letters for fall enrollment mailed on or about February 1. For spring, decisions are mailed beginning in early November.

Applicants to the University are admitted on the total merit of their applications. While academic criteria such as grades, quality and level of courses, test scores, trend of grades, and rank are primary, involvement in leadership and school and community activities, recommendations, and how effectively an applicant communicates strengths and interests, are also important (and sometimes crucial) elements in an admission decision. There is no automatic cutoff in the admission process, either in GPA, test scores or rank, as the Admissions Committee is aware of differences in how secondary schools grade and rank their students, as well as ways in which secondary-school offerings and competitiveness vary. Home-schooled applicants with well-documented educational and personal achievement records are invited to apply.

The Admissions Committee seeks to enroll the strongest and most diverse class possible. Candidates are urged to make full use of the Supplementary Admission Form. The Admissions Committee is sensitive to all types of achievement and welcomes information about the candidate's values, aspirations and personal challenges. Students who meet both academic and financial criteria may be admitted to the Educational Opportunity Program, and students living in Broome and Tioga counties are afforded a degree of flexibility in the admission process. Candidates with special skills and talents may request a review of those skills by checking the appropriate box on the Supplementary Admission Form and following the instructions noted on the form.

Early Admission

Applicants who have completed their junior year of high school but have not graduated may be considered for admission. Approval of such early admission is contingent on the student's meeting the normal entrance requirements and admission criteria. Early applicants should submit the regular application form. Note that persons who have not graduated from high school may be ineligible for some forms of financial aid.

Deferred Admission

Students who wish to defer their enrollment for one or two semesters, after having been admitted and having paid their tuition deposit, should contact the Admissions Office. Deferments are not automatically given but, dependent on the admission competition and general demand for them, may be granted for some of the undergraduate schools.

External Placement

External examination credit includes credits earned through Advanced Placement (AP), International Baccalaureate (IB), College Level Examination Program (CLEP) credits, Regents College Exams Program credits, DANTES Standard Subject Tests (DSST) or through official transcript evaluation of courses taken at other institutions. Selected external credits may apply to General Education or major requirements as specified. Advanced Placement examinations with a grade of 3 or better are approved for credit, with the amount and applicability determined by the appropriate academic unit. There is a maximum of *32 credits* allowed for AP transfer credit. (See Appendix page 63 – AP Equivalency Chart.)

Calculus (AB) AP Exam:

- *A score of 3 or 4* is equivalent to an unspecified lower-level math course and student must pass the Binghamton calculus diagnostic test in order to register for MATH 221.
- *A score of 5* is equivalent to MATH 221 + 4 additional credits of unspecified lower-level math (8 credits).

Calculus (BC) AP Exam:

- *A score of 3* is equivalent to an unspecified lower-level math course and student must pass the Binghamton calculus diagnostic test in order to register for MATH 221.
- *A score of 4* is equivalent to MATH 221.
- *A score of 5* is equivalent to MATH 221 + 4 additional credits of unspecified lower-level math (8 credits).

International Baccalaureate (IB) Program

The following all-University policy applies to entering students who have completed the International Baccalaureate diploma: such students will receive a full year's credit (32 credit hours) if they have achieved a total of *30 or more* points on the IB diploma and have passed *at least 3 higher level exams with scores of 5 or higher*. However, due to the curricular requirements of EE and CoE degree, only 8 of these credits are likely to apply to the degree. Specifically, the General Education Social Sciences (N) requirement and the Humanities (H) requirement will be fulfilled by the IB degree. For other students who have participated in the IB program, 8 (eight) credit hours will be given for each higher level exam passed with a score of 6 or 7. For higher level exams passed with a score of 4 or 5, 4 (four) credit hours will continue to be given. The number of these credits that apply to the EE or CoE degrees will depend on the specific IB courses taken.

CLEP (College Level Examination Program)

This is a credit exam program run by the College Board and ETS. ACE recommends 3-6 credits for each subject (however, Binghamton University grants 4) with a minimum or credit granting score of 50 or higher. This is considered equivalent to a grade of "C" or better. Of the 2 types of exams, subject and general, only the subject is considered for credit. Starting in 2001, all CLEP exams became computer based. The credit granting score was also standardized to 50 for all subject exams. Prior to 2001, all exams were paper-based and the credit granting score would vary from subject to subject. The U.S. Military will continue to use paper-based exams through March 31, 2004. The credit granting score on these paper-based exams will vary. Please note that some credit recommendations are for 6 credits and in the case of foreign languages, 12 credits. However, only 4 credits are awarded for the 6 credit recommendations and 8 credits where ACE has recommended 12 credits.

Articulation Agreements

Articulation Agreements between Binghamton University and many community colleges facilitate the transfer of students from those colleges into the various programs and schools of the University. Agreements exist between all members of the Two-Year Engineering Science Association (TYESA), such as those listed on page 17 and others.

Transfer Students to Electrical & Computer Engineering

Students transferring into the Engineering Design Division (freshman year of engineering) have their credits transferred on a course-by-course basis. Any courses in which they receive a grade of C- or better and which apply to their major requirements will transfer. Students transferring into the junior year of computer engineering or electrical engineering often hold the degree of associate of science in engineering science, as defined by the SUNY Two-Year Engineering Science Association (TYESA). Members of TYESA have designed associate of science programs that closely match program requirements of the Watson School so that transfer into Watson School programs is facilitated.

Members of the TYESA include: Adirondack Community College, Broome Community College, College of Technology at Alfred, College of Technology at Morrisville, Corning Community College, Dutchess Community College, Fulton-Montgomery Community College, Hudson Valley Community College, Jamestown Community College, Jefferson Community College, Nassau Community College, Onondaga Community College, and Tompkins-Cortland Community College.

Transfers into electrical or computer engineering who expect to enter at the junior level should have completed the following courses, if they intend to complete the BS in EE or CoE in two years of full-time study, beginning in a fall semester. Credits are transferred on a course-by-course basis, as per the list below:

- (a) Calculus I and II, Differential Equations
- (b) 2 (two) semesters of Calculus-based physics
- (c) 1 (one) course in college Chemistry and one additional course in Science/Math
- (d) 2 (two) courses in English Composition or Technical Writing
- (e) 2 (two) courses in Humanities / Social Science (best if US History / World History or Western Civilization)
- (f) First course in Electrical Circuits
- (g) Introductory Programming Course in C or C++
- (h) Probability and Statistics (Note: If not available, then Calculus III (for EE) or Discrete Mathematics (for CoE) can be taken and ISE 261 can be completed after transfer.)
- (i) Data Structures and algorithms
- (j) Microprocessors
- (k) Digital Logic

ECE does not accept transfer courses equal to EECE 3xx (junior level) courses.

Students also transfer from a variety of other backgrounds, entering at various levels depending upon an evaluation of their transfer credits. Any questionable course is evaluated in consultation with a faculty adviser. Any student who is not ready for the sophomore year is usually placed in the Engineering Design Division. Occasional exceptions are made for non-traditional students who are partially ready – often someone with technical experience from the military who knows exactly what department he or she wishes to enter with hands on experience in the discipline.

Those who plan to enter ECE from Binghamton University's Harpur College (or another area) via intra-University transfer (IUT) are advised to meet with the director of Watson Advising to insure adequate sophomore year preparation prior to filing the IUT with Watson Advising. That approach is unique to engineering, as only engineering IUT applicants are reviewed and decided upon before Undergraduate Admissions handles the paperwork. All applicants, with decisions noted, are sent to Admissions for official processing, with pertinent file information sent directly to the appropriate department to begin their file and assign a faculty adviser.

General Education Notes

Social science electives prior to junior-level transfer should cover one U.S. History, one World History, and one additional social science (preferably economics) to efficiently meet Binghamton University's General Education requirements.

Spring Transfers

In many cases, students who transfer to Binghamton University in the spring will require at least five semesters to graduate, due to the fact that most junior and senior ECE courses are only offered once per year. Spring transfers, therefore, require special advising based on their individual backgrounds.

Physics Transfers

By long standing articulation agreements with SUNY 4-year colleges with Physics departments, students may transfer into the Watson School after three years of physics and graduate with both a BSEE and a baccalaureate in Physics simultaneously. This program "double-counts" some courses, with the same course satisfying an engineering requirement at one school and a physics requirement at the other school. Neither degree can be awarded before the full five years has elapsed without forfeiting this "double-counting."

Financial Aid

The Financial Aid Services Office is committed to helping students find the resources they need to make their college education affordable. Below are a few things to keep in mind:

1. Financial aid offers are determined by information you provide on the Free Application for Federal Student Aid (FAFSA). Students are encouraged to file their FAFSA online via <http://www.fafsa.ed.gov/>. **Binghamton University's FAFSA school code is 002836.** Offers include institutional scholarships* as well as federal and state aid.
2. February 1 is the priority deadline for filing the FAFSA. Students planning to enter in the spring term should file by November 15. If you miss these deadlines, please be aware that you can still file. However, funding for need-based financial aid is limited, and is offered on a first-come, first-served basis.
3. New York State residents are eligible for Tuition Assistance Program (TAP) awards. After you file your FAFSA, the information is forwarded to TAP. As a result, you will receive a preprinted Express TAP application. March 1 is the priority deadline for Express TAP applications for the fall. **Binghamton University's TAP school code for undergraduates is 0880. The TAP school code for graduate students is 5450.**
4. To receive federal and/or state funding, students must meet general eligibility criteria established by both agencies and coordinated through the Financial Aid Services Office. In addition, students must attend classes, and be making satisfactory academic progress. Federal and State academic progress guidelines can be found via <http://bingfa.binghamton.edu/academic.htm>.

The following Financial Aid information can be found at <http://bingfa.binghamton.edu/apps.htm>: Types of Aid, First-Time/Transfer Students, Returning Students, Graduate Students, Educational Opportunity Program (EOP), International Students, Financial Aid Appeals, Financial Aid Timeline, Summer Aid, and Accepting your Aid Award.

V. ACADEMIC PROGRAMS

Core Curricula: Electrical and Computer Engineering

The following section outlines the core curricula for the Bachelor of Science in Electrical Engineering and the Bachelor of Science in Computer Engineering degrees. Students who enroll as aspiring engineering freshmen in the Watson School are initially under direction of the Division of Engineering Discovery and Design. The goal of this division is to provide students the opportunity to develop the skills required for success as students today and as leaders tomorrow - no matter which final profession they choose. The freshman year is common to all engineering majors.

<i>Freshman Year / Fall Semester</i>	<i>Credits</i>
MATH 221. Calculus I (M)	4
CHEM 111. Chemical Principles (L)	4
WTSN 103. Engineering Communications I	2
WTSN 111. Exploring Engineering I	2
General Education Elective (P)	4
Body/Wellness Requirement (Y, S, B)	1
	<i>Total</i> <i>17</i>

<i>Freshman Year / Spring Semester</i>	<i>Credits</i>
MATH 222. Calculus II	4
PHYS 131. General Physics I	4
WTSN 104. Engineering Communications II	2
WTSN 112. Exploring Engineering II (J)	2
General Education Elective (G)	4
Body/Wellness Requirement (Y, S, B)	1
	<i>Total</i> <i>17</i>

Total Credits – 1st year: 34

To receive the BS EE or BS CoE degree, students must complete a minimum of 125 credit hours covering all degree requirements with a cumulative grade-point average of at least 2.0, plus a minimum of 2.0 in the core requirements for Electrical or Computer Engineering. (Most students complete with more than the minimum number of credits required, with 125 credits allowing for variances in transfer credits from other institutions.) In addition, all Binghamton University students must also meet the General Education requirements.

Electrical Engineering Curriculum: Final three years

<i>Sophomore Year / Fall Semester</i>	<i>Credits</i>
MATH 371. Ordinary Differential Equations	4
PHYS 132. General Physics II	4
CS 211. Programming I for Engineers	4
EECE 251. Digital Logic Design	4
EECE 281. ECE Seminar I	1
<i>Total</i>	<i>17</i>

<i>Sophomore Year / Spring Semester</i>	<i>Credits</i>
CS 212. Programming II for Engineers	4
ISE 261. Probabilistic Systems I	4
EECE 252. Microprocessors	4
EECE 260. Electrical Circuits	4
<i>Total</i>	<i>16</i>

<i>Junior Year / Fall Semester</i>	<i>Credits</i>
EECE 301. Signals and Systems	4
EECE 315. Electronics I	4
EECE 332. Semiconductor Devices	3
MATH 323. Calculus III	4
EECE 382. EECE Seminar II	1
<i>Total</i>	<i>16</i>

<i>Junior Year / Spring Semester</i>	<i>Credits</i>
EECE 323. Electromagnetics	4
EECE 361. Control Systems	3
EECE 377. Communication Systems	3
EECE 387. Design Lab	4
General Education (H) Requirement	4
<i>Total</i>	<i>17</i>

<i>Senior Year / Fall Semester</i>	<i>Credits</i>
EECE 487. Senior Project I (J)	4
Technical Elective I	3
Professional Elective I	4
General Education (A) Requirement	4
<i>Total</i>	<i>15</i>

<i>Senior Year / Spring Semester</i>	<i>Credits</i>
EECE 488. Senior Project II (H)	4
Technical Elective II	3
Professional Elective II	3
General Education (N) Requirement	4
<i>Total</i>	<i>14</i>

Total Credits – 4 years 129

Computer Engineering Curriculum

<i>Sophomore Year / Fall Semester</i>	<i>Credits</i>
MATH 371. Ordinary Differential Equations	4
PHYS 132. General Physics II	4
CS 211. Programming I for Engineers	4
EECE 251. Digital Logic Design	4
EECE 281. EECE Seminar I	1
<i>Total</i>	<i>17</i>

<i>Sophomore Year / Spring Semester</i>	<i>Credits</i>
CS 212. Programming II for Engineers	4
ISE 261. Probabilistic Systems I	4
EECE 252. Microprocessors	4
EECE 260. Electrical Circuits	4
<i>Total</i>	<i>16</i>

<i>Junior Year / Fall Semester</i>	<i>Credits</i>
EECE 301. Signals and Systems	4
MATH 314. Discrete Math	4
EECE 315. Electronics I	4
EECE 351. Digital Systems Design	4
EECE 382. ECE Seminar II	1
<i>Total</i>	<i>17</i>

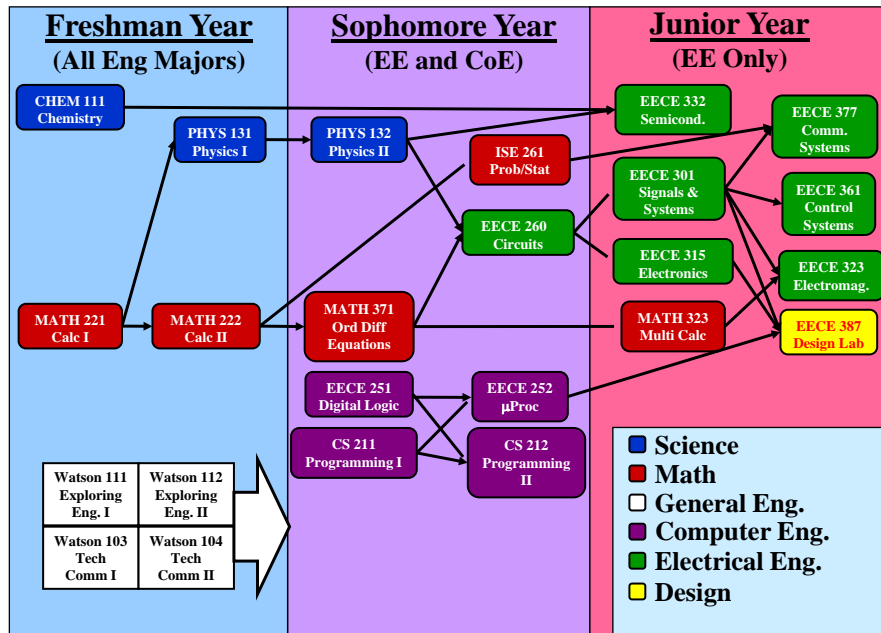
<i>Junior Year / Spring Semester</i>	<i>Credits</i>
EECE 359. Computer Communications and Networking	4
EECE 352. Computer Architecture	3
EECE 387. Design Lab	4
General Education (H) Requirement	4
<i>Total</i>	<i>15</i>

<i>Senior Year / Fall Semester</i>	<i>Credits</i>
EECE 487. Senior Project I (J)	4
CS 311. Operating Systems Concepts	4
Technical Elective I	3
General Education (A) Requirement	4
<i>Total</i>	<i>15</i>

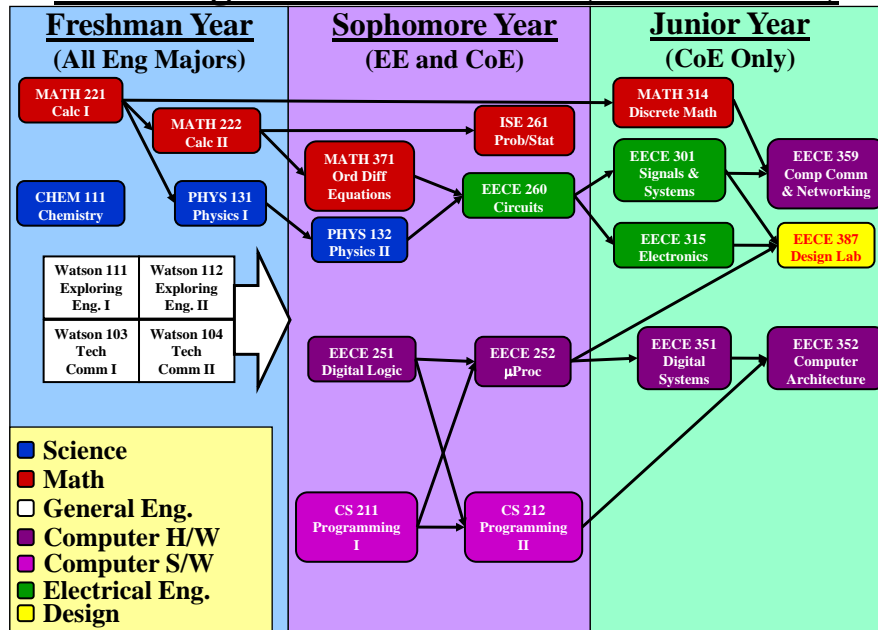
<i>Senior Year / Spring Semester</i>	<i>Credits</i>
EECE 488. Senior Project II (H)	4
Professional Elective I	4
Technical Elective II	3
General Education (N) Requirement	4
<i>Total</i>	<i>15</i>

Total credits – 4 years 129

EE Program Main Courses (First 3 Years)



CoE Program Main Courses (First 3 Years)



General Education Requirements

Binghamton University has had a General Education program for all undergraduate students since 1996, which meets State University of New York (SUNY) requirements. As a condition of graduation, baccalaureate students entering BU in 2000 or later are required to complete a General Education program of *no fewer than 30 credit hours* specifically designed to achieve learning outcomes in 10 knowledge and skill areas: Mathematics; Natural Sciences; Social Sciences; American History; Western Civilization; Other World Civilizations; Humanities; The Arts; Foreign Language; and Basic Communication, and two competencies: Critical Thinking (Reasoning) and Information Management. **ECE students who enter BU as freshman, satisfy the Mathematics, Laboratory Science, and Composition/Oral Communication requirements as part of the ECE major requirements.**

Gen. Ed. Requirements <i>satisfied by ECE major</i>	Gen. Ed. Requirements <i>not satisfied by ECE major</i>
(M) Mathematics	(H) Humanities
(L) Laboratory Science	(P) Pluralism in the United States
(J) Joint Composition / Oral Communication <i>[(J) satisfies (C) and (O) requirements simultaneously.]</i>	(Y) Physical Activity, (S) Wellness, or (B) Physical Activity/Wellness
	(G) Global Interdependencies
	(N) Social Sciences
	(A) Aesthetics
<i>* Foreign language requirement waived for engineering students only.</i>	

Courses that satisfy General Education requirements are so designated in the Schedule of Classes each semester. The code letter attached to a course in the Schedule of Classes means that the course fulfills the particular General Education requirement that follows. The Schedule of Classes can be found via the BU Brain Portal website at <https://bubrain.binghamton.edu/> and can be sorted by General Education Requirement. The 10 knowledge and skill areas are further sorted into 5 categories, as summarized below:

Category 1: Language and Communication

Composition (C) courses are courses in any of the departments or divisions of the University. They require a process of revision and a minimum of 20 pages of expository prose. Students will perform the basic operations of personal computer use; understand and use basic research techniques; and locate, evaluate and synthesize information from a variety of sources. At least 50 percent of the course grade is based on student writing. **[Requirement satisfied during freshman year Watson sequence.]**

Oral Communication (O) courses involve at least two oral presentations and evaluation of speaking that count for at least 15 percent of the final course grade.

NOTE: The language of communication for fulfilling both the C and O requirement shall be English.

Category 2: Creating a Global Vision

The complexity of the modern world demands that students attain a heightened awareness both of the plurality of cultures that have contributed to the making of the United States and of the interdependence of the cultures of the world.

Pluralism in the United States (P) courses consider three or more cultural groups in the United States in terms of their specific experiences and how they have affected and been affected by the basic institutions of American society. Each course takes substantial account of at least three of the following: African Americans, Asian Americans, European Americans, Latino Americans and Native Americans. **[Freshman year, spring semester elective. Examples: GEOG 103: Multicultural Geographies of the U.S.; HIST 104A: Modern American Civilization; WOMN 100A: Introduction to Women's Studies.]**

NOTE: Most "P" courses assume a basic knowledge of United States history, as measured by demonstrating a level of proficiency equivalent to a score of *85 or above* on the Regents examination on United States History and Government or passing the Advanced Placement exam in U.S. History with a score of *3 or better*. Students who have not demonstrated this knowledge must meet the "P" requirement by choosing from among a designated group of "P" courses that pay significant attention to a broad span of United States history.

Global Interdependencies (G) courses consider how one or more of the regions of the world have influenced and interacted with the West and with one another, and how the West has affected and been affected by these regions and their distinctive cultures or civilizations. Additionally, major portions of the course content focus both on broad, foundational aspects of the long-term development of distinctive features of Western civilization in Europe and North America and on the distinctive features of one or more non-Western civilizations, such as those of Asia, Africa or the indigenous peoples of the Americas. **[Freshman year, fall semester elective. Examples: GEOG 101: Introduction to Geography; HIST 130A: Modern World History; SOC 100A: Social Changes: Introduction to Sociology.]**

Category 3: Natural Sciences, Social Sciences and Mathematics

Students must have an understanding of the methods of investigation typical of the natural and social sciences and must be able to make individual observations and quantitative measurements in a hands-on environment in the natural sciences. In order to have the experience of discovery through the use of logic and reasoning, students also need to study mathematical methods and reasoning.

Laboratory Science (L) courses emphasize the formulation and testing of hypotheses and the collection, analysis and interpretation of data. Each course includes a minimum of 10 laboratory meetings, exercises, field studies or practica. **[Requirement satisfied during freshman year Watson sequence – specifically, CHEM 111.]**

Social Science (N) courses emphasize the major concepts, models and issues of at least one of the social sciences. **[Senior year, spring semester elective. Examples: ANTH 111: Introduction to Anthropology; ECON 160B: Principles of Microeconomics; PLSC 117: Introduction to World Politics.]**

Mathematics/Reasoning (M) courses include any course in the Mathematics Department numbered 130 or above, any of several designated statistics courses, or any of several designated logic courses. An Advanced Placement score of *3 or better* in Calculus or Statistics may be used to satisfy this requirement. **[Requirement satisfied during freshman year Watson sequence – specifically, MATH 221.]**

Category 4: Aesthetics and Humanities

By taking courses in this area, students gain an expanded sense and understanding of culture and a greater appreciation of human experience and its expressions.

Aesthetics (A) courses enhance students' understanding of the creative process and the role of imagination in it. Students study or practice artistic expression and production in such fields as art, art history, cinema, creative writing, dance, graphic design, music and theater. **[Senior year, fall semester elective. Examples: ARTS 161: Beginning Photography; MUSC 101: Introduction to Music; ARTH 286R: Eastern European Art and Architecture.]**

Humanities (H) courses enhance students' understanding of human experience through the study of literature or philosophy. **[Senior year, spring semester elective. Examples: PHIL 101: Introduction to Philosophy; ENG 117R: Understanding Poetry; COLI 230: Classical Mythology; CLAS 214: Greek Drama.]**

Category 5: Physical Activity/Wellness

Exercise, body awareness and wellness are essential components of a healthy and productive lifestyle. The dictum we follow is “a sound mind in a sound body.”

Physical Activity (Y) courses devote at least 50 percent of their time to the performance of physical exercise designed to develop one or more of the following attributes: neuromuscular skill, muscular strength and endurance, cardiovascular endurance, flexibility. **[Freshman year, fall and spring semester electives. Examples: HPEY 111: Karate (1 credit); HPEY 119: Tennis/Racquetball (1 credit); HPEY 176: Fly Fishing (1 credit).]**

Wellness (S) courses deal with such topics as diet and nutrition, physical development, substance abuse, human sexuality, relaxation or physical, mental and

emotional fitness. Their focus is on developing a healthy lifestyle rather than on simply providing information about the human body. [**Freshman year, fall and spring semester electives. Examples: HPE 111: Love Thyself (1 credit); HPEY 158: Rape Aggression Defense (1 credit)**]

NOTE: The **Physical Activity/Wellness** requirement may be fulfilled in any of the following ways:

- Completion of a one-credit (or more) Physical Activity course and a one-credit (or more) Wellness course.
- Completion of a one-credit Physical Activity/Wellness course and one of the following:
 - one-credit Physical Activity course;
 - one-credit Wellness course;
 - one-credit Physical Activity/Wellness course.
- Completion of a two-credit (or more) course that combines a physical activity and wellness.

NOTE: **Physical Activity** and **Wellness** components may be combined to create **Physical Activity/Wellness (B)** courses. [**Examples: HPEY 104: Swim for Fitness (1 credit); HPEY 160: Yoga; HPEY 177: Hiking (1 credit).**]

Note: Under the general terms of pass/fail, these rules apply: A “P” does not affect a grade point average. An “F” does factor into the grade point average, regardless of whether the class is taken for a letter grade or under the pass/fail option. **However:** HPEY courses receiving an “F” DO NOT AFFECT GPA and HPEY courses are NEVER taken for a letter grade.

Electives

For the EE curriculum, a total of two (2) technical electives and two (2) professional electives are required. For the CoE curriculum, a total of two (2) technical electives and one (1) professional elective are required. This section gives guidance on approved technical and professional electives. Students may also obtain permission to take other electives from their advisor, provided a strong case is made.

***Pre-Approved Technical Electives for EE Majors**

- 1) EECE 400 – 486;
- 2) Non-required core courses, EECE 351, 352, and 359
EECE 351: Digital Systems Design
EECE 352: Computer Architecture
EECE 359: Computer Communications and Networking

***Pre-Approved Technical Electives for CoE Majors**

- 1) Non-required CS courses; CS 231 – 481;
- 2) EECE 400 – 486;
- 3) Non-required core courses, EECE 323 – 377:
EECE 323: Electromagnetics
EECE 332: Semiconductor Devices
EECE 361: Control Systems
EECE 377: Communications Systems

***Pre-Approved Professional Electives for EE and CoE Majors**

ACCT	321 – 475
ASTR	321 – 475
BCHM	321 – 475
BIOL	321 – 475
CHEM	231 – 499
CS	300 – 390, 400 – 472
ECON	321 – 475
EECE	323 – 377 (EE only), 400 – 486, 491, 496
GEOG	321 – 475
GEOL	321 – 475
ISE	211, 231, 300 – 486
MATH	300 – 389, 400 – 489 (except Math 327 & 447)
ME	272, 273, 274, 300 – 494
MGMT	321 – 475
PHYS	323 – 342, 411 – 474

** Any course not listed as Technical or Professional Elective would need signed approval from a Faculty Advisor on a DARS Exception Form – available from the Watson School Advising Office or the ECE department front office.*

Course Substitutions

Appropriate substitutions for required courses can usually be found among the ECE senior technical electives. Exact substitutions are not necessary, as long as the substitute course fits in with the student's program. Occasionally, a substitution for an existing required course is requested in the last semester in order to allow a student to graduate without staying an extra semester, usually as a result of having dropped a course.

All course substitutions require a *DARS Exception Form*, which can be found at Watson Advising or the ECE department front office and must be signed by the Department Chair or Undergraduate Program Director. Any significant deviation from the published requirements requires a *General Academic Petition Form*, signed by both the Department Chair or Undergraduate Program Director and Watson School Advising.

Taking Graduate Courses as an Undergraduate

In their last semester, seniors may have the prerequisites or the motivation to take a graduate course for undergraduate credit. In order to do so, permission of the instructor is required. After gaining permission, an email from the instructor should be sent to the ECE department secretary who can then enroll the undergraduate student in the graduate course.

Undergraduate students who are within eight credits of graduation may register for up to two graduate-level courses and receive graduate credit, provided the graduate courses are not used to meet the undergraduate degree requirements. (These courses are offered at undergraduate tuition rates when the student is within eight credit hours of graduation and files the necessary form.) When graduate courses are not taken with the intent of fulfilling undergraduate requirements, such graduate hours do not count toward full-time status for financial aid purposes; thus, undergraduates taking graduate courses may not be eligible for certain types of financial aid.

To receive graduate credit for such courses, the undergraduate student must complete the *Petition to Receive Graduate Credits as an Undergraduate* form (available from the Registrar or the Graduate School). The form is then filed with the Registrar and the Student Accounts Office before registration.

While graduate courses taken by undergraduates (and not used to meet undergraduate degree requirements) will appear on the undergraduate transcript, these courses are not counted toward the undergraduate degree or used in the calculation of the final GPA. The credits may be counted toward the graduate degree.

An exception to these policies is made for undergraduate students admitted to combined bachelor's/master's degree programs.

Courses at Other Institutions

Any Watson School student who wishes to take a course at another institution and use it towards any degree requirement must seek both department and Watson School Advising Office pre-approval on a *Petition to Take Courses at Another Institution* (pg 58) form to insure proper transfer credit with the minimum required grade. An official course description is required (i.e., copy of catalog description, web link, etc.) prior to approval and a copy of the signed form is kept in both the Watson School Advising Office and the department. Evaluation of the suitability of transfer credits follows the same process as evaluation of transfer credits. Upon receipt by the Watson Advising Office, an official transcript matching the pre-approved course, the student is awarded credit for the course if they have achieved the minimum required grade.

Independent Study, Industrial Internship, Undergraduate Research and Teaching Practicum

EECE 497 (Independent Study), EECE 496 (Industrial Internship), EECE 499 (Undergraduate Research), and EECE 491 (Teaching Practicum) can be used to satisfy the Professional Elective requirement and care must be exercised to insure that the appropriate work is performed by the student for the credit awarded.

EECE 496 – Industrial Internship

Internships either in the Binghamton area or elsewhere are highly encouraged by the Department of Electrical and Computer Engineering. At the discretion of the faculty advisor, one internship may be applied towards up to 3 credits of EECE 496 Industrial Internship; subsequent internships can be taken with a pass/fail option only. The 3 credits of EECE 496 taken with normal grade option may be used to fulfill the requirements for one professional elective. Internships may not be used as a technical elective and may not be used for more than one professional elective. In order to receive academic credit, students must complete the *Internships as a Professional Elective* form (purple) which can be acquired via the ECE department and must fill in basic information about the internship, such as the sponsoring organization, dates, and nature of work to be done. The processing of this form should be initiated by the student prior to the start of the internship period. At the end of the internship, the employer or sponsoring organization will be asked to comment about the work actually done and give a brief rating of the quality of the work performed by the student and sent directly to the ECE department for processing.

EECE 491 – Teaching Practicum

Students majoring in both electrical and computer engineering are encouraged to work with faculty advisors as course assistants in laboratory classes. To be eligible, students must be in good academic standing overall and have already earned at least a B grade in the course for which they are assisting. Students should register for EECE 491 – Teaching Practicum for 1 to 4 credits (typically 3), as

agreed to with the faculty supervisor for the course. Teaching Practicum may count for one professional elective and may normally not be used to satisfy a technical elective unless significant work is done and always at the discretion of the Chair or Undergraduate Program Director. Although the student may enroll for a second teaching practicum, only the first practicum can be counted toward degree requirements.

Students may assist in a course in a number of ways, depending on the nature of the course and the needs of the instructor teaching the course. The exact role of the student is determined in consultation with the instructor. In all cases, however, the student must actively participate in the teaching/learning process. For example, it is not sufficient for the student to simply grade papers. Generally, the number of direct contact hours with students should be at least equal to the number of credits being taken (e.g. 3 hours assisting in lab). However, the total hours per week should be closer to 1.5 to 2 times the number of credits to match a typical class.

Enrollment in EECE 491, 496, 497, and 499

For a student to enroll in an Independent Study, Industrial Internship, Undergraduate Research, or Teaching Practicum, registration on a yellow *Independent Study Form* obtained from their respective department is required. Students cannot register for these courses using BU Brain. The form includes the name, signature, CRN (course registration number), and “faculty section number” of the faculty member who will be responsible for grading the course and must then be returned to the ECE department. The student must have some documentation stating the conditions of the course required to obtain credit. The ECE department staff will place a copy of this documentation in the student’s file.

Dual Majors in Electrical and Computer Engineering

Students may elect to double major in both electrical and computer engineering, subject to the following general guidelines:

- Students must take all required “major” courses for each major and at least 32 “major” credits beyond the minimum required for either major alone. Typically, the double major would require approximately 157 to 160 total credits and requires 5 years to complete.
- For the CoE “home” major, additional courses would include EECE 323, 332, 361, 377, Math 323, two additional technical electives, and two additional professional electives.
- For the EE “home” major, additional courses would include EECE 351, 352, 359, CS 350, Math 314, two additional technical electives, and one additional professional elective.

Departmental Honors Programs

The ECE Honors Program is designed to intellectually challenge extremely well-qualified students during their undergraduate college experience. Students in the ECE Honors Program are required to satisfy three general requirements.

The general requirements to earn the Departmental Honors designation are that the student must:

- Complete two graduate courses as senior electives;
- Conduct approved research or perform a significant industrial project under the supervision of a professor in the department, typically this is demonstrated by presentation of a conference paper or preparation and defense of a thesis (similar to a graduate defense), and
- Maintain a minimum 3.5 GPA.

Program Benefits

Some of the benefits of the engineering honors program are:

- Interaction with other highly motivated and academically successful students,
- Close collaboration with a research or consulting professor during the junior and/or senior year
- Potential opportunity to attend and present a paper at a national professional conference, and
- Additional "with departmental honors" designation to permanent transcripts.

Eligibility

Students in the second and third undergraduate years are eligible for admission to the program. Due to the additional course, research, and project requirements of the program, seniors are not eligible for initial admission to the program.

The number of students admitted to the program is limited by each department.

The general requirements for eligibility are:

- 1) 3.5 GPA
- 2) Application essay
- 3) Recommendations from at least one ECE faculty member, and
- 4) Interview with the ECE Undergraduate Studies Committee.

Accelerated Master's Degree Programs for Students Pursuing the BS in Electrical Engineering or BS in Computer Engineering

A combined **BS and MSEE** degree program is available for motivated students working toward the BS in electrical or computer engineering. To be eligible, undergraduate students must have a GPA of **3.5 or higher** after five semesters (fall semester, junior year). Students apply for admission to the combined-degree program during their junior year by completing a short application available in the Watson School Advising Office. Once admitted to the program, students begin taking graduate courses during their senior year. Up to three graduate courses taken in the student's senior year can count both toward their MS degree requirements and their senior elective requirements. By January 15 of the senior year, a formal application for Graduate School admission must be completed, which assuming continued good performance, is only a formality.

After admission to the graduate program, students are encouraged to seek employment as a graduate research assistant in one of the department's research projects. The research experience gained in the summer after finishing the BS degree provides an excellent experience and a start on an MS thesis project. Typically this start on the MS thesis allows the completion of the MS thesis option in one academic year beyond the BS degree. The expectation is that students in the program will complete the BS and MS degrees in five years. Students in the combined-degree program receive their BS degree after completing their undergraduate requirements. They must then continue as a full-time student in order for the graduate courses taken as an undergraduate to count toward the MS degree requirements. The MS degree is an excellent professional credential, which usually commands a substantially higher starting salary. The combined program offers the advantage of less time to degree completion, finishing the MS while a full-time student rather than an extended part-time program, and the ability to start employment at the master's level.

A combined **BS and MBA** degree program provides Watson undergraduate students with the opportunity to complete their BS degree and MBA degree within five years. In order to complete this program, students will be required to apply and take four MBA courses during the senior year, as seen below. A minimum 3.0 GPA and a GMAT score of at least 600 are required to apply. Upon completion of their senior year, students receive their BS degree. In the fifth year they are officially admitted to the MBA program.

Electrical Engineering: Senior Year (Fast Track MBA)

<i>Fall Semester</i>	<i>Credits</i>
EECE 487. Senior Project I (J)	4
Technical Elective I	3
MGMT 501 Accounting (Professional Elective I)	4
MGMT 505 Finance (Professional Elective II)	4
	<hr/>
<i>Total</i>	<i>15</i>

<i>Spring Semester</i>	<i>Credits</i>
EECE 488. Senior Project II (H)	4
Technical Elective II	3
General Education (A) Requirement	4
MGMT 502 Economics (Gen. Ed. N Requirement)	4
MGMT 507 Operations Management*	4
<i>Total</i>	<i>19</i>

Computer Engineering: Senior Year (Fast Track MBA)

<i>Fall Semester</i>	<i>Credits</i>
EECE 487. Senior Project I (J)	4
CS 350. Operating Systems	4
MGMT 501 Accounting (Professional Elective I)	4
MGMT 505 Finance (Technical Elective I)	4
<i>Total</i>	<i>16</i>

<i>Spring Semester</i>	<i>Credits</i>
EECE 488. Senior Project II (H)	4
Technical Elective II	3
General Education (A) Requirement	4
MGMT 502 Economics (Gen. Ed. N Requirement)	4
MGMT 507 Operations Management*	4
<i>Total</i>	<i>19</i>

More information about this program is available on the School of Management (SoM) website, <http://www2.binghamton.edu/som/prospectivestudents/graduate/fasttrackmba/fasttrackmbawatson.html>. Advising for the MBA program and courses is provided by the SoM, not the ECE department.

- * MGMT 507 can be taken during the Winter session instead. However, a better option would be to complete the spring semester General Education course earlier in the program or over a summer.

VI. STUDENT ADVISING

Initial advisement of students begins before the start of the first semester in the Watson School. New student orientations are held for both freshmen and transfer students admitted for fall or spring. Transfer students and community college faculty advisers often consult with Watson School advisers prior to student application to ensure appropriate pre-Watson course choices.

After admission, the Watson School departments and the Watson School Advising Office share responsibility for student advisement, with the faculty as the main source of academic guidance. Watson Advising, open year-round during regular business hours, is staffed by two professional advisers (Director and Associate Director), a full time secretary, and student peer advisers. Students can visit on an informal walk-in basis or may schedule appointments with professional advisers. The ECE department has an Undergraduate Program Director who coordinates with Watson Advising to handle specific EE and CoE-related advising issues throughout the year.

For engineering freshmen, the Engineering Design Division (EDD) faculty takes the lead through their ongoing contact with the students in the Discovering Engineering and Technical Communications courses. This is supplemented with support from Watson Advising to handle general advising issues.

Upon entry into the EE or CoE program, each student is assigned to a faculty advisor who will provide guidance throughout the student's stay at Binghamton. Each faculty advisor follows the guidelines in this handbook to check and monitor the status of a student and when recommending courses. Each semester, during course pre-registration periods, each student is required to meet with their assigned faculty advisor. These meetings have several purposes, including:

- A careful review of the student's DARS report to ensure they are maintaining satisfactory progress towards completion of program and university General Education requirements;
- Review of the student's course selection for the following semester to ensure prerequisites are met and to keep the student on track towards completion of degree requirements;
- Providing guidance in the selection of technical and professional electives and humanities and social sciences courses;
- Discussion of academic issues such as GPA, course load, transfer credits, etc.
- Discussion of career path issues and planning for graduate school.

The student's progress is recorded on the student's EE or CoE *Student Advising Record*, which is signed by both the student and the advisor. In addition, comments regarding any issues discussed with the student are recorded and notations are made for topics to consider at the next advising session. Each student's advising record is maintained in ECE department files as an on-going means of ensuring the quality and consistency of advising over the duration of the student's stay at Binghamton. Additional support from Watson Advising provides ample opportunity for students to address any concern in a timely manner.

Advising Process

In order to provide quality service and consistent guidance, the ECE department has implemented the following advising procedure:

- 1) Students who are going to be Juniors and Seniors in the coming Fall semester and students who are Sophomores (Juniors and Seniors) in the coming Spring semester will receive an email from the ECE department, noting the name of their faculty advisor and the core courses that will be blocked for the upcoming semester. Students should keep in mind that certain core courses are blocked in both the fall and spring semesters.
- 2) Students need to:
 - determine their assigned faculty advisor from the posted and emailed list
 - print their DARS
 - fill out the Registration Release form, which can either be printed or obtained from the forms holder outside Q2, the ECE department front office.
- 3) Students then need to take both the DARS and Registration Release forms to their faculty advisor during posted office hours for advising.
- 4) Signed Registration Release forms are to be delivered to the department front office (Q2) for proper course registration.

Each semester, advising office hours are posted on the ECE department bulletin board, as well as on each faculty member's bulletin board located outside their office.

Catalog Year

The Catalog Year is the most important criterion for making advising judgments since it is the "contract" under which a student has been matriculated. The courses required for graduation are determined by the listings in the appropriate part of the University Catalog for that year. The catalog year appears on the transcript and on the DARS form. Advisors should provide themselves with catalogs or photocopies of the ECE Physics and Math sections for academic years as far as 4 or 5 years past. Watson Advising has back issues of the catalog for reference. The Binghamton University website also publishes this information.

Changes in the ECE curriculum over several catalog years have resulted in the discontinuance/introduction of old/new required courses. Students have the option of changing their catalog year to the most recent year. However, this may not be in the student's best interest due to the required courses that may have been added recently. Watson Advising has information on all university-wide changes that occur.

Change of Grade

Change of grade after submission to the Registrar by the instructor is to be made only in the case of a makeup of a grade of Incomplete or as a result of clerical error. The instructor must submit the Change of Grade form directly to the Registrar. Change of grade forms have a stamped # or serial number on the form that should be recorded in the instructor's grade sheet.

Undergraduate Transfers

Students occasionally apply for transfer with the Associate of Science in **Applied Science**, which is a **Technology** degree and does not have math and calculus-based science requirements of the AS/ES. These transfer credits are individually reviewed by Watson Advising and they begin in the department or Engineering Design Division with the understanding that they will need at least three (3) years to complete the BS EE or CoE degree, depending on their background. Some of these students have taken the calculus-based science which was not required for their Technology degree and may be fairly well-qualified.

Particular attention should be paid to the "proficiency in a computer language" requirement for transfer to EE or CoE. Students with marginal background are advised to postpone taking the required CS 212 (Programming II for Engineers) and to take CS 211 (Programming I for Engineers) in the fall semester to strengthen their proficiency. These students may then take a General Education course or senior technical elective in the summer to make room in their senior year schedule to make up CS 212, or stay the summer of their senior year and graduate in August instead of May.

Declaration of Candidacy

In order to graduate at the end of the semester, a student must submit an *Application for Undergraduate Degree* form to the Registrar **before the last day to add** deadline at the beginning of the prior semester. The intent is to alert the student to deficiencies in time to make appropriate registration for their last semester. Forms are available online, in the Watson Advising office, and from the Registrar. This form is used by the Registrar to be sure the student receives various important notices in preparation for graduation.

Final Examinations

Students are not expected to take more than three (3) final examinations in a twenty-four hour period. Immediately after review of their schedule, students should contact the faculty and attempt to resolve this on their own. If a resolution cannot be reached, the student should work with Watson Advising.

VII. ELECTRICAL AND COMPUTER ENGINEERING UNDERGRADUATE COURSES

REQUIRED EE and CoE Courses

EECE 251: Digital Logic Design

[4 credits; fall]

Fundamental and advanced concepts of digital logic. Boolean algebra and functions. Design and implementation of combinatorial and sequential logic, minimization techniques, number representation, and basic binary arithmetic. Logic families and digital integrated circuits and use of CAD tools for logic design. Laboratory exercises.

Corequisites: PHY 132

EECE 252: Computer Organization and Microprocessors

[4 credits; spring]

Organization of computer systems: processor, memory, I/O organization, instruction encoding and addressing modes. Introduction to microprocessors, control unit, and interrupt system design. Design of hardware and software for microprocessor applications. Assembly language programming. Microprocessor system case studies. Laboratory exercises.

Prerequisites: EECE 251 and CS 211

EECE 260: Electric Circuits

[4 credits; fall]

Units and definitions. Ohm's Law and Kirchhoff's Laws. Analysis of resistive circuits. Circuit analysis using: Nodal and mesh methods, Norton and Thevenin theorems, and voltage divider. Transient and sinusoidal steady-state response of circuits containing resistors, capacitors, and inductors. Laboratory exercises.

Prerequisites: PHYS 132 and MATH 371

EECE 281: Electrical and Computer Engineering Seminar I

[1 credit; fall]

Overview of the fields of electrical engineering and computer engineering. Various sub-fields within EE and CoE are explored, with emphasis on how they are interrelated. Issues relevant to careers in EE and CoE (e.g., typical tasks done by EEs and CoEs) are explored.

Prerequisites: Sophomore standing in EE or CoE program

EECE 301: Signals & Systems

[4 credits; fall]

Provides an introduction to continuous-time and discrete-time signals and linear systems. Topics covered include time-domain descriptions (differential and difference equations, convolution) and frequency-domain descriptions (Fourier series and transforms, transfer function, frequency response, Z transforms, and Laplace transforms).

Prerequisites: EECE 260 and MATH 371

EECE 315: Electronics I

[4 credits; fall]

Introduction on electronics, concentrating on the fundamental devices (diode, transistor, operational amplifier, logic gate) and their basic applications; modeling techniques; elementary circuit design based on devices. Laboratory exercises.

Prerequisites: EECE 260 and EECE 251

EECE 382: Electrical and Computer Engineering Seminar II

[1 credit; fall]

Provides an overview of the professional aspects of the fields of Electrical Engineering and Computer Engineering. Topics to be covered include: typical career paths in EECE, engineering ethics, resume writing and job search techniques, preparing for graduate school, professional engineer license, etc.

Prerequisites: Junior Standing in EE or CoE program

EECE 387: Design Lab

[4 credits; spring]

Students will complete a series of assigned design projects that rely on background in the areas of microprocessors, electronics, and signals & systems. Lecture will focus on various aspects of the design process, as well as discussion of component characteristics.

Prerequisites: EECE 252, EECE 301, and EECE 315

EECE 487: Senior Project I

[4 credits; fall]

Design projects in cooperation with local industry and other external clients. Specifications, proposal, time schedule, and paper design. Periodic design reviews with client, written and oral progress reports, final presentation. Evaluation based on individual and team performance.

Prerequisites: EECE 387 and Senior Standing

EECE 488: Senior Project II

[4 credits; spring]

Continuation of EECE 487. Prototype fabrication and test. Demonstration and documentation of functioning system delivered to client. Evaluation based on individual and team performance.

Prerequisites: EECE 487 or consent of Instructor.

EE REQUIRED Courses / CoE Electives

EECE 323: Electromagnetics

[4 credits; spring]

Fundamentals of electromagnetic fields, Maxwell's Equations, plane waves, reflections. Application to transmission lines, antennas, propagation, electromagnetic interference, electronics packaging, wireless communication.

Prerequisites: EECE 301 and MATH 323

EECE 332: Semiconductor Devices

[3 credits; fall]

Basic theory of semiconductors, p-n junctions, bipolar junction transistors, junction and MOS field effect devices; device design and modeling, fabrication.

Prerequisites: PHYS 132. Corequisite: EECE 315

EECE 361: Control Systems

[3 credits; spring]

Introduction to analysis, design, and modeling of control systems. Fourier and Laplace transforms, frequency response, transfer functions, and transient analysis. Systems block diagrams and signal-flow graphs. Concepts of stability. Numerical simulation and design of simple control systems. Introduction of discrete-time control.

Prerequisites: EECE 301

EECE 377: Communications Systems

[3 credits; spring]

Fundamentals of communications systems. Modulation and demodulation methods. Characteristics of modern analog and digital communications methods.

Prerequisites: EECE 301 and ISE 261

CoE REQUIRED Courses / EE Electives

EECE 351: Digital Systems Design

[4 credits; fall]

Synchronous sequential circuit design. Algorithmic state machine method; state reduction; control-data path circuit partitioning. Design of sequential arithmetic circuits. Memory interfacing; bus-based design. Specification and synthesis of digital systems using hardware description language and implementation using programmable logic devices. Simulation, analysis, testing, and verification of digital systems. Laboratory exercises.

Prerequisites: EECE 252

EECE 352: Computer Architecture

[3 credits; spring]

Computer architecture, pipelined architecture, RISC machines and instruction sets. Static and dynamic scheduling of instructions. Instruction-level parallelism, advanced pipelining, superscalar and super-pipelined processors. Virtual memory organization, memory hierarchies, input-output and cache memory. Compiler issues.

Prerequisites: EECE 351

EECE 359: Computer Networks

[4 credits; spring]

Theoretical basis for and practical foundations of modern data communications within and between computing systems. Topics include: properties of signals and transmission media; data encoding and modulation, multiplexing, and multiple access; data security and integrity, error control coding and forward error correction, compression, data encryption; protocol concepts and design, flow control, sliding window protocols, data link control; local area networking, LAN standards, and interconnecting LANs; networking and inter-networking devices, bridges, repeaters, routers; inter-networking protocols. Lab exercises.

Prerequisites: EECE 301 and EECE 351

EE and CoE Electives

EECE 402: Digital Signal Processing

[3 credits; spring]

Covers the general area of discrete-time signals and the analysis and design of discrete time systems. Topics include time domain analysis, solutions of difference equations, Z-transform analysis, sampling of continuous-time signals, discrete Fourier transforms, Fast Fourier Transforms, and spectral analysis. Processing of discrete-time signals using the DFT and FFT. Design and implementation of discrete-time filters. Extensive use of software simulations in a high-level language such as Matlab. Technical elective.

Prerequisite: EECE 301

EECE 405: Cryptography and Information Security

[3 credits; fall]

Introduction to codes and ciphers, and information security. Cryptanalysis (code breaking), modern block and stream ciphers, public-key cryptography, protocols, security engineering and threat management. Key exchange, digital cash, digital voting, anonymity protocols. Technical Elective.

Prerequisites: ISE 261 or MATH 327

EECE 416: Analog Circuit Design

[3 credits; fall]

Introduction to analog circuit design including integrated circuits. Course topics include large and small-signal analysis, sub-threshold and above-threshold designs, basic integrated circuit processing and layout, circuit characteristics (gain, input/output resistance, etc), amplifier structures, frequency/time response, feedback and stability, noise, and temperature effects. This course includes several projects requiring the use of industrial CAD tools for integrated circuit design, layout, and simulation.

Prerequisite: EECE 315

EECE 418: Electric Power Systems Engineering

[3 credits, spring]

This course will cover the basics of electric power systems including developments related to the more widespread use of intermittent renewal energy sources. Topics in the course will include a review of fundamental circuit principles related to power system networks, principles of magnetic theory related to power systems, transformers, synchronous generators, AC and DC transmission lines, power flow, stability and control in interconnected power systems, power fault analysis, and other general characteristics of electric power systems.

Prerequisites: Course in Circuit Theory

EECE 419: Power Electronics Design

[3 credits; fall]

Electrical processing of electrical energy. Overview of power electronics devices such as DMOSFET, IGBT and Thyristors. Power supply circuits from AC or DC sources as used in computers, inverters and variable-speed motor drives. Analytical and numerical techniques for simulation. Technical elective.

Prerequisites: EECE 315 and EECE 301

EECE 421: Electric Drives

[3 credits; spring]

Fundamentals of electric drive systems with applications emphasis. The course offers an integrative treatment of multiple components that make up electric drives, including electrical machines, power-electronics-based converters, mechanical systems, feedback controller design, and the interaction of the drives with the utility grid.

Prerequisites: EECE 260, EECE 301 and EECE 323

EECE 422: Principles of Electro-Mechanical Systems

[3 credits; spring]

With the surge in use of electro-mechanical systems ranging from robotic systems to small passenger vehicles to multi-megawatt windmills, and many other systems, there is an increasing need for a combination of electrical engineering and mechanical engineering expertise applied to electro-mechanical systems. Fundamental technical areas from electrical engineering include basic circuit theory, power electronics, DC motors and generators,

control theory, and batteries. Fundamental technical principles from mechanical engineering include torque, vibration, heat dissipation, stress and strain, and strength of materials. Controls, reliability, efficiency and coupling between electrical drives and internal combustion engines are important topics spanning both mechanical and electrical engineering. These technical areas will be covered from a systems perspective. The course is intended for electrical or computer engineering majors with limited background in mechanical engineering and mechanical engineering majors with a limited background in electrical engineering. Prerequisite: Senior standing in either electrical engineering or mechanical engineering or permission of course instructor.

Prerequisites: Senior standing in electrical, computer or mechanical engineering and a course in Circuit Theory

EECE 432: Physics & Tech of Solar Cells

[3 credits; every other spring]

This course focuses on the science, engineering fundamentals of the photovoltaic solar energy devices and systems. The lectures would cover solar radiation, semiconductor properties, p-n junction theory, solar cell operating principles and device designs and fabrication of traditional crystalline silicon and thin film solar cells. Students will learn the advanced concepts for high efficiency solar cells and emerging photovoltaic devices like organic (plastic) solar cells and quantum solar cells. The course would cover solar module interconnections, engineering design of solar electricity systems and storage and power conditioning at systems level.

Prerequisites: EECE 332 or equivalent is desirable but not essential

EECE 438: System on a Chip Design

[3 credits; spring]

Overview of the components of system-on-a-chip (SOC) design from initial technology and architectural choices, to SOC implementation issues (e.g., performance, core selection, on-chip communication networks, power management, package constraints and cost). Also covered are SOC design and implementation processes (e.g., functional integration, simulation, clocking strategies, timing, design for test, and debug strategies).

Prerequisites: EECE 252 and EECE 315

EECE 451: Digital Systems Design II

[3 credits; spring]

In this course, we focus on the design and synthesis technologies using Verilog Hardware Description Language (HDL) at the Register-Transfer level (RTL). Verilog programming and simulation basics will be discussed, followed by advanced Verilog programming for synthesis. Principles of RTL synthesis will be introduced. The Design Compiler synthesis tool from Synopsys will be discussed in detail. In the final project, 3~4 person teams will be formed and work on the design and synthesis of a large-scale digital circuit using Design Compiler. The pre-synthesis and post-synthesis results will be verified by the ModelSim software.

Prerequisite: EECE 351

EECE 455: CMOS VLSI Circuits & Architectures

[3 credits; fall]

The topics include the principles of MOSFET transistors, characteristics of CMOS digital circuits, layout design and process, performance analysis of CMOS gates, circuit design styles using MOSFET, performance, area and power optimization of CMOS circuits. Commercial design and simulation tools will be used in the class. Laboratory assignments include design, layout, extraction and simulation.

Prerequisite: EECE 351

EECE 457: Security Engineering

[3 credits; spring]

Introduction to security engineering, systemic analysis and common design principles. Cryptography, multilevel security, system evaluation, real-world vulnerabilities and attacks.

Prerequisites: EECE 252 or CS 220; familiarity with C or C++ or similar programming language

EECE 462: Control Systems II

[3 credits; fall]

Conventional and state variable techniques for the analysis and design of digital and analog control systems. Z-transform. Sampled data systems. Discrete state variable. Numerical simulation and computer-aided design of control systems. Technical elective.

Prerequisite: EECE 361

EECE 474: Electro-Optics

[3 credits; fall]

Electro-optic devices and systems. Blackbody, LED and laser sources, photo detectors, modulators, fiber optics, Fourier optics. Design of electro-optic systems. Technical elective.

Prerequisite: EECE 323

EECE 477: Digital Communications

[3 credits; fall]

Fundamentals of digital communication systems. Baseband modulation and demodulation. Spread spectrum. Signal space representation. Bit error rate. Bandwidth efficiency and power efficiency of various digital modulation methods. Link analysis. Technical elective.

Prerequisite: EECE 377

EECE 491: Teaching Practicum (see pg. 29 for a full description)

[var. cr.; every semester]

Assist with undergraduate instruction of a formal course under the direct supervision of the course instructor. May count for one professional elective and may normally not be used to satisfy a technical elective unless significant work is done and always at the discretion of the Chair or Undergraduate Program Director. **Prerequisite:** permission of department chair

EECE 496: Industrial Internship (see pg. 29 for a full description)

[var. cr.; every semester]

Engineering work experience in industry. Daily log book, memo progress reports and formal final report required. May satisfy, at most, one professional elective.

Prerequisite: permission of department chair

EECE 497: Independent Study

[var. cr.; every semester]

Individual study under direct supervision of a faculty member. Approval of proposed subject by the faculty member and department chairman must be obtained prior to registration.

Prerequisite: permission of department chair

EECE 499: Undergraduate Research

[var. cr.; every semester]

Assist with faculty research. Approval of proposed subject by the faculty member and the department chairman must be obtained prior to registration.

Prerequisite: permission of department chair

VIII. WATSON SCHOOL STUDENT ORGANIZATIONS

All Watson School students are eligible to receive the services provided for all students at Binghamton, and to participate in the various student activities. Students should familiarize themselves with the *Bulletin* sections on services for students and student activities.

Societies of particular interest to many EE and CoE students are:

Association of Computing Machinery (ACM)

Engineers Without Borders

Eta Kappa Nu (electrical engineering honor society)

Institute of Electrical and Electronics Engineers (IEEE)

National Society of Black Engineers (NSBE)

Society of Automotive Engineers (SAE)

Society of Hispanic Professional Engineers (SHPE)

Society of Indian American Engineers and Architects

Society of Women Engineers (SWE)

Tau Beta Pi (engineering honor society)

Theta Tau (national engineering fraternity)

Upsilon Pi Epsilon (honor society for the computing sciences)

IX. CONTACT INFORMATION

Electrical and Computer Engineering Department: EB (3rd floor), Q2

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Dr. Douglas Summerville Associate Professor and Undergraduate Director dsummer@binghamton.edu	EB, P10	777-2942
ECE Departmental Fax		777-4464

Watson School of Engineering and Applied Science: LSG, Rm. 546

Dr. Hari Srihari, Dean sdesu@binghamton.edu	LSG, 544	777-2871
Mrs. Susan Boyce, Secretary to the Dean sboyce@binghamton.edu	LSG, 546	777-2871
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Ms. Lorna Wells, Director of Watson School Advising lornawel@binghamton.edu	LSG, 509	777-6203
Ms. Sharon Santobuono, Assoc. Director of Watson Advising santobu@binghamton.edu	LSG, 507	777-6099

Binghamton University Contacts:

Admissions, Undergraduate	AA, 101	777-2171
Financial Aid Services and Registrar	SW, 109	777-2428
Watson School Advising Office	LNG, 552	777-6203

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