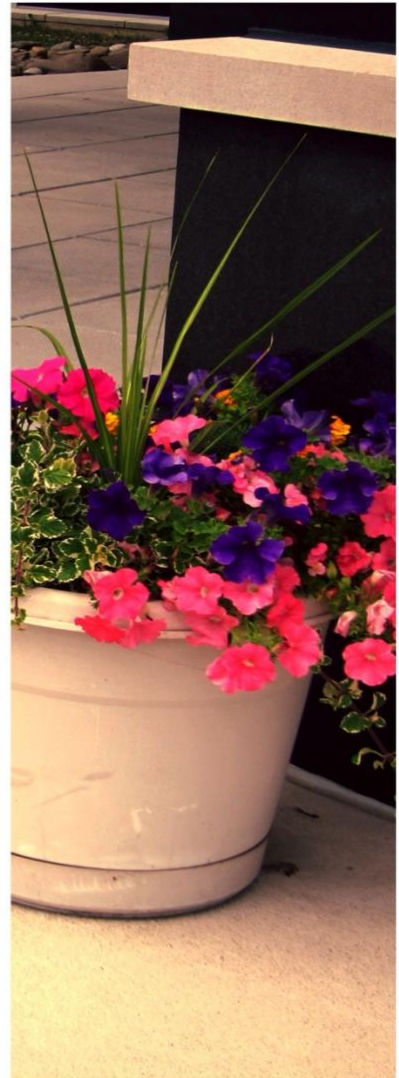


ELECTRICAL & COMPUTER ENGINEERING UNDERGRADUATE HANDBOOK



BINGHAMTON UNIVERSITY
State University of New York

Thomas J. Watson College of Engineering & Applied Science

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 the Engineering Accreditation Commission ABET, <http://abet.org>.

Program Educational Objectives

Graduates of the EE and CoE programs should be on a path to proficiency in the following four areas:

1. **Leadership:** Graduates will be known for leadership, innovation, entrepreneurship, or 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. **Adaptability:** Graduate will demonstrate flexibility 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/service, or government or public service.

Student Outcomes

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

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

II. DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING OVERVIEW

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 and largest engineering disciplines. Electrical engineers work in the areas of design, analysis and application of electrical and electronic components, circuits, and systems. Electrical engineers work in areas focused on the analysis, design and application of information processing systems such as communication systems, medical imaging systems and sensors; others are focused on power and energy, such as power transmission and design of electric drives. The areas in which electrical engineers work span the spectrum from the atomic level to systems level design. An electrical engineer may focus on the physical operation of micro-electronic devices, integrated circuits, electronic circuits, or systems that process and transmit signals, information and electrical power.

Computer Engineering (CoE) encompasses the design of computers and other digital systems, emerging as a bridge between electrical engineering and computer science. Driven by technological advancements that have made computing technology inexpensive and small enough to incorporate into a wide-range of products and systems, computer engineering is now one of the core engineering disciplines. The scope of products and systems containing computer technology is ever-expanding, ranging from small embedded computers in consumer electronics, appliances and automobiles, to complex computer-based systems controlling power generation, manufacturing, and telecommunications systems. The role of the computer engineer includes the design, analysis and implementation of computing technology as well as its integration into devices and systems that use computers as components or tools. As a result, computer engineers work in many industries, including aerospace, automotive, computer, defense, electronics, information technology, networking and telecommunications.

The first year is common among all the engineering programs in the Watson College 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 or Computer Program, but the courses remain 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 provides insight 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, job search techniques, preparing for graduate school, professional engineer licensure, 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 breadth 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 with the skills and knowledge necessary for a dynamic career in either Electrical or Computer Engineering, or a variety of other careers.

III. UNDERGRADUATE ADMISSIONS

General Education Requirements Statement

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 are required to complete a General Education program from the following categories: Language and Communication, Creating a Global Vision, Liberal Arts, and Physical Activity/Wellness. Detailed information regarding these requirements can be found in Section IV of this handbook.

General Education FAQ's:

<https://www.binghamton.edu/academics/general-education/student-info.html>

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).

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.

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) Linear Algebra and Engineering Programming
- (j) Sophomore Design
- (k) Digital Logic

For transfer students from SUNY two year colleges, please refer to URL below, which is the seamless transfer agreement that encompasses all SUNY two year and four year schools. Click on the link for **Engineering: Computer** or **Engineering: Electrical**. To transfer “seamlessly” you should take all the courses listed for the computer/electrical major. Institution specific courses for Binghamton include courses equivalent to ISE 261, Probability and Statistics and EECE 287, Sophomore Design. You may either take equivalent courses at your two year school or take these courses after you transfer to Binghamton. For more information: <https://www.suny.edu/attend/get-started/transfer-students/suny-transfer-paths/suny-transfer-paths-all/>

ECE does not accept any transfer courses for 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.

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 a Watson academic advisor to ensure adequate sophomore year preparation prior to filing the IUT application. All decisions are made by Watson Advising, in consultation with engineering faculty. The Office of Undergraduate Admissions is notified of all decisions, informs applicants and oversees the change of schools and curriculum code in consultation with the Office of Student Records. Watson Advising then sends pertinent file information directly to the appropriate department to assign a faculty adviser.

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.

Transfers with Associate of Science in Applied Science Degree

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 the student begins in the 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.

For CoE students in particular, special attention should be paid to the "proficiency in a computer language" requirement. Students with marginal background are advised to take CS 211 (Programming I for Engineers) in their first fall semester at Binghamton, immediately before taking CS 312 the following spring.

Financial Aid

The Financial Aid Office is committed to helping students find the resources they need to make their college education affordable.

Visit <https://www.binghamton.edu/financial-aid> where you can find numerous types of aid and valuable information.

IV. ACADEMIC POLICIES

The Watson College generally follows the University-wide academic policies which are all available on the Binghamton University website <https://www.binghamton.edu>. The following policies also apply to Watson College 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 *University Academic Guide* current at the time they are admitted. However, undergraduate students who interrupt enrollment for three or more consecutive semesters are governed by the *Academic Guide* in effect when they are readmitted.

Academic Integrity

All students must adhere to the Student Academic Honesty Code of the University and the Watson College. The Department of Electrical and Computer Engineering has adopted a standard policy to enforce these codes for violations involving course work.

Category I violations result in a grade of 0 for the graded work plus a one letter course grade reduction. A *Report of Category I Academic Dishonesty* form is filed with the Provost's Office; if a prior report is already on file, the offense is automatically elevated to Category II. Category II violations result in at least a failing grade for the course plus any additional penalties determined by the Watson Academic Integrity Committee. Watson College Academic Honesty Code:

<https://www.binghamton.edu/watson/about/academic-honesty.html>

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 College student may take, without an approved petition, is *18 credits*. General academic petitions to overload are only necessary for students that do not meet the 3.3 GPA for an automatic overload. No incompletes are allowed at the time of the overload.

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

Requirements for Degrees Statement

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

Student Advising

Initial advisement of students begins before the start of the first semester in the Watson College. New student orientations are held for both freshman and transfer students admitted for fall. Transfer students and community college faculty advisers

often consult with Watson College advisers prior to student application to ensure appropriate pre-Watson course choices.

After admission, the Watson College departments and the Watson College Advising Office share responsibility for student advisement, with the faculty as the main source of academic guidance. Watson Advising is open year-round during regular business hours and students can visit on a walk-in basis or may schedule appointments with professional advisers. Students can schedule an appointment through STARFISH via BU BRAIN to meet with an individual adviser in Watson Advising. The ECE department has an Undergraduate Director who coordinates with Watson Advising to handle specific EE and CoE-related advising issues throughout the year.

For engineering **freshman**, 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 (usually as **sophomores**) 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, group advising sessions are done by the undergraduate director when visiting sophomore and junior level courses. All students are encouraged to meet with their advisor on an individual basis. These meetings have several purposes, including:

- A careful review of the student's DegreeWorks report to ensure they are maintaining satisfactory progress towards completion of program;
- Review of the student's course selection for the following semester to ensure prerequisites are met;
- Providing guidance in the selection of technical and professional electives;
- Discussion of academic issues such as GPA, course load, transfer credits, etc.
- Discussion of career path issues and planning for graduate school.

Comments regarding any issues discussed with the student are recorded and notations are made for topics to consider at the next advising session. Additional support from Watson Advising provides ample opportunity for students to address any concern in a timely manner.

Student Monitoring via Degree Works

Note to students and faculty advisors

- *With regard to fulfilling general education requirements, please seek advising via the Watson Advising Office only.*
- *Since GenEd requirements are overall university requirements, rather than ECE requirements, the ECE faculty are likely not familiar with the details.*

Questions or problems with the report can be addressed with the student's faculty advisor, ECE Undergraduate Director, and/or Representatives of the Watson Advising Office.

In general, 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.

For students, **Degree Works**:

- Provides real-time advice and counsel
- Students are strongly encouraged to meet with a professional adviser before registering for the Spring Junior level classes (bring a copy of your degree works with you).
- Speeds time to graduation
- Provides intuitive web access to self-service capabilities
- Streamlines the graduation process
- Tracks transfer courses that have been used to fulfill degree requirements
- Notes exceptions or substitutions that have been approved by the Electrical and Computer Engineering Undergraduate Program Director or the ECE Department Chair
- **Monitors 30 required degree credits of math and science as mandated by ABET**
- Allows direct access to multiple related services and advice through hyperlinks to catalog information, class schedules, transcripts, help desk services, and FAQs

Students use their PODS user name and password to gain access through BU BRAIN, proceeding to the **Your Records** tab and then clicking **DegreeWorks**.

For advisors, **Degree Works**:

- Supports real-time delivery of academic advice through intuitive web interfaces
- Minimizes errors through consistent degree plans
- Supports more timely degree certification
- Reduces paperwork and manual program check sheets
- Supports and monitors unique program changes

Faculty advisors use their PODS user name and password to gain access through BU BRAIN, proceeding to the **Faculty/Staff** tab and then clicking **Degree Works**.

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. Advisors can find the ECE Physics and Math sections for previous academic years via the university website.

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.

Advanced Placement Credit

External examination credit includes credits earned through Advanced Placement (AP), 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. Similar performance on other tests such as those of the International Baccalaureate (IB) are also allowed to meet requirements. There is a maximum of 32 credits allowed for AP transfer credit.

AP Exam	Equivalency (4 credits unless otherwise stated)	General Education Requirement Fulfilled
Art History	Score 3 –elective credits	Aesthetics (A)
	Score 4 or 5 – ARTH 110	
Biology	Score 3 – MSCI XXX same	Score 4 or 5 – Laboratory Science (L)
	Score 4 – with DSON college code = BIOL 113 L GenEd	
	Score 4 – for all other schools = BIOL XXX L GenEd	
	Score 5 – BIOL 113 and 114 L GenEd	
Calculus A B	Score 3, 4, or 5 – MATH 224/225	Mathematics / Reasoning(M)
Calculus B C	Score less than 3 with 3 subscore on AB exam – MATH 223/224	Mathematics / Reasoning (M)
	Score less than 3 with 4 or 5 subscore on AB exam – MATH 224/225	
	Score 3 – MATH 224/225	
	Score 4 - Math 223/224/225/226	
	Score 5 - Math 224/225/226/227	
Chemistry	Score 3 – CHEM 101	Score 4 or 5 – Laboratory Science (L)

AP Exam	Equivalency (4 credits unless otherwise stated)	General Education Requirement Fulfilled
	Score 4 – CHEM 111 or CHEM 107	
	Score 5 – CHEM 107 and CHEM 108 (8 credits)	
Chinese Language & Culture	Score 3, 4 or 5 - elective credit	Foreign Language (FL3)
Comparative Government and Politics	Score 3, 4, or 5 – PLSC 113	Social Science (N)
Computer Science A	Score 3, 4 or 5 – CS free elective	
Computer Science Principles	Score 3,4 or 5 – CS free elective	
English: Literature & Composition	Score 3, 4 or 5 – elective credit	Humanities (H)
English: Language & Composition	Score 3, 4 or 5 – elective credit	
Environmental Science	Score 3 - ENVI 101 Score 4 – ENVI 101 + L GenEd Score 5 – ENVI 101 & 201 L GenEd total of 8 credits	Score 4 or 5 – Laboratory Science (L)
European History	Score 3, 4 or 5 – elective credit	Social Science (N)
French Language and Culture	Score 3, 4 or 5 – elective credit. Consult with dept. if you plan to take additional courses	Foreign Language (FL3)
German Language and Culture	Score 3 or 4 – elective Score 5 – GERM 203. Consult with dept; may be used toward major	Foreign Language (FL3)
Human Geography	Score 3, 4 or 5 – GEOG 101	Social Science (N)
	Score 3 – ITAL 211	
Italian Language and Culture	Score 4 or 5 – ITAL 215 Consult with dept. if you plan to take additional courses	Foreign Language (FL3)
Japanese Language and Culture	Score 3, 4 or 5—elective credit	Foreign Language (FL3)
	Score 3 – elective credit	
Latin	Score 4 or 5 – LAT 203 Consult with Classical and New Eastern Studies Department to determine whether this may count toward the major.	Humanities (H) Foreign Language (FL3)
Macroeconomics	Score 3, 4 or 5 – ECON 160 or 162	Social Science (N)
Music Theory	Score 3, 4 or 5—elective credit	Aesthetics (A)
Physics 1: Algebra-based	Score 3 or 4 – elective credit	Score 5 – Laboratory Science (L)

AP Exam	Equivalency (4 credits unless otherwise stated)	General Education Requirement Fulfilled
	Score 5 – PHYS 121	
Physics 2: Algebra-based	Score 3 or 4 - elective credit Score 5 – PHYS 122	Score 5 – Laboratory Science (L)
Physics B (Discontinued May 2014)	Score 3 or 4 – elective credit Score 5 – PHYS 121 and 122 (eight credits)	Score 5 – Laboratory Science (L)
	Score 3 or 4 – elective credit	
Physics C	Score 5 (Mechanics) – PHYS 131 Score 5 (Electricity & Magnetism) – PHYS 132	Score 5 – Laboratory Science (L)
Psychology	Score 3, 4 or 5 – elective credit PSYC 111 Score 3 – SPAN 211	Note: Does not fulfill Gen Ed
Spanish Language and Culture	Score 4 or 5 – SPAN 215 May be used toward major; consult with department regarding placement if you plan to take additional courses	Foreign Language (FL3)
Spanish Literature and Culture	Score 3 – SPAN 250 Score 4 or 5 – SPAN 251	Humanities (H) Foreign Language (FL3)
Statistics	Score 3, 4 or 5 – MATH 147A	Mathematics/Reasoning (M)
Studio Art: 2-D Design	Score 3, 4 or 5 – elective credit	Aesthetics (A)
Studio Art: 3-D Design	Score 3, 4 or 5 – elective credit	Aesthetics (A)
Studio Art: Drawing	Score 3, 4 or 5 – elective credit	Aesthetics (A)
United States Government and Politics	Score 3, 4 or 5 – PLSC 111	Social Science (N)
United States History	Score 3, 4 or 5 – elective credit	Social Science (N)
World History	Score 3, 4 or 5 – elective credit	Social Science (N)

Watson General Education Requirements

All newly admitted Watson College students are subject to the General Education requirements. The chart below only shows what the EE or CoE curriculum fulfills, it is not a list of all the requirements.

Watson College GenEd Requirements fulfilled by EE or CoE

General Education Requirement	Fulfilled by
Composition course (C)	Covered by (J)
Oral Communication (O)	Senior Design Sequence
Joint Oral Communication/Composition (J) (Courses satisfy both the <i>C and O</i> simultaneously)	WTSN Freshman Sequence
Laboratory Science (L)	Chemistry 107, 111 (Also Physics 131)
Mathematics/Reasoning (M)	Calculus I
Foreign Language	Waived for all Watson Students
Critical Thinking (T) and Information Literacy (I) core competencies	Senior Design sequence 487/488

Grading System

Students who enroll in courses offered outside of Watson College undergraduate programs are graded according to the grading system of the school offering the course. Watson College 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. Only courses taken with a letter grade option can be used to satisfy program requirements (except for general education courses that are only offered pass/fail).

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.

All add/drops should be processed through your schedule on BU BRAIN before the add/drop deadline as stated on the academic calendar. (Note: No changes are made to an undergraduate record after two years have passed.)

Late Add/Drop: Once the add/drop deadline passes, all late add/drops are requested through BU BRAIN via a petition. A \$20 fee per course will be charged to your student account.

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 Office of Student Records, located in the Admissions Center.

Incompletes

Instructors may temporarily submit a grade notation of Incomplete, which appears in grade reports as “I.” A contract of the Incomplete should be established that includes a timeline and requirements for completion. For continuing students 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 approve a request for an extension – form available through the Registrar’s Office. 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.” Graduating students must complete the work within 30 days in order to graduate that semester. If not completed, the grade will automatically become a “W”. Both W or F grades can retroactively affect financial aid. Students are urged to speak with the Financial Aid Office. The Incomplete Contract form can be found through the ECE website under Resources for Current Undergraduate Students.

Watson College 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. The electronic form can be found on BU Brain under the **Student** tab/registration. The request is sent directly to the instructor for further processing. You can monitor the progress of your request via BU Brain. You will be notified via email if further information is needed or of the final decision.

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 calculated into the grade-point average. When a course is repeated in which the student earned a failing grade the first time, 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** and are currently enrolled in 12 credits, are placed on the Dean's Honors List. 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

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 academic probation who again fail to meet both the 2.0 cumulative GPA and the last-semester GPA in the table below are suspended. Students who meet the last-semester GPA requirement but still post a cumulative GPA under 2.0 remain on academic probation.

Suspension becomes effective immediately when it is imposed. The duration for academic suspension is one semester, and students are not considered for readmission during that period. After the minimum of one semester away from school, students

seeking readmission are required to contact the Watson Advising Office to discuss their academic plan and begin the readmission process.

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

Dismissal: Students who, after being suspended and readmitted, once again fail to meet the required academic standards are dismissed.

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

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

Withdrawal and Re-enrollment

Undergraduate students who withdraw from the Watson College during any semester and wish to remain in good standing must follow a formal withdrawal procedure. Mere absence from class does not constitute withdrawal. Students can access the late withdrawal form through BU BRAIN. It is advised to first speak with or meet with a representative from the Watson Advising office. After the proper paperwork is submitted and approved, 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 College applies the same withdrawal and re-enrollment policies as established for the university, except that Watson College students may drop below a 12-credit program without permission.

Undergraduate students must apply for re-enrollment through the Undergraduate Admissions Office if they have not been in attendance for two or more semesters. Re-enrollment 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.

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.

Change of Grade

Change of grade after submission to the Office of Student Records, 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 directly through BU BRAIN.

Application for Degree and Commencement Participation

To graduate at the end of a semester, a student must submit the *Application for Undergraduate Degree* form and the *Commencement Participation* form. Forms are available at <http://www.binghamton.edu/commencement/> and should be filled out prior to the withdraw deadline of their final semester. These forms are used by the Office of Student Records to be sure the student receives various important notices in preparation for graduation.

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 freshman in the Watson College are initially under direction of the Engineering Design Division. 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 224/225.	Differential Calculus/Integral Calculus (M)	4
CHEM 111.	Chemical Principles (L)	4
EDD 103.	Engineering Communications I	2
EDD 111.	Introduction to Engineering Design	2
General Education Elective (G, P, A, N, H)		4
Physical Activity/Wellness Requirement (Y, S, B)		1
<i>Total</i>		<i>17</i>

<i>Freshman Year / Spring Semester</i>		<i>Credits</i>
MATH 226/227.	Integration Techniques and Application/Infinite Series	4
PHYS 131.	General Physics I	4
EDD 104.	Engineering Communications II	2
EDD 112.	Introduction to Engineering Analysis (J)	2
General Education Elective (G, P, A, N, H)		4
Physical Activity/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 127 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 127 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 324.	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>
EECE 212.	Linear Algebra & Eng Programming	4
ISE 261.	Probabilistic Systems I	4
EECE 287.	Sophomore Design	4
EECE 260.	Electric 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
Professional Elective I		3
<i>Total</i>		<i>17</i>

<i>Senior Year / Fall Semester</i>		<i>Credits</i>
EECE 487.	Senior Project I (O)	2
EECE 486.	Senior Project I Lab	1
Technical Elective I		3
General Education (G,P,A,N,H) Requirement		4
General Education (G,P,A,N,H) Requirement		4
<i>Total</i>		<i>14</i>

<i>Senior Year / Spring Semester</i>		<i>Credits</i>
EECE 488.	Senior Project II	2
EECE 489.	Senior Project II Lab	1
Technical Elective II		3
Professional Elective II		3
General Education (G,P,A,N,H) Requirement		4
<i>Total</i>		<i>13</i>

Total Credits – 4 years **127**

Computer Engineering Curriculum: Final Three Years

<i>Sophomore Year / Fall Semester</i>	<i>Credits</i>
MATH 324. 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>
EECE 212. Linear Algebra & Eng Programming	4
ISE 261. Probabilistic Systems I	4
EECE 287. Sophomore Design	4
EECE 260. Electric 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 Mathematics	4
EECE 315. Electronics I	4
EECE 351. Digital Systems Design	4
EECE 382. EECE Seminar II	1
<i>Total</i>	<i>17</i>

<i>Junior Year / Spring Semester</i>	<i>Credits</i>
EECE 359. Computer Comm and Networking	4
CS 312. Programming II for Engineers	4
EECE 387. Design Lab	4
General Education (G,P,A,N,H) Requirement	4
<i>Total</i>	<i>16</i>

<i>Senior Year / Fall Semester</i>	<i>Credits</i>
EECE 487. Senior Project I (O)	2
EECE 486. Senior Project I Lab	1
CS 352. Operating Systems Concepts	4
Technical Elective I	3
General Education (G,P,A,N,H) Requirement	4
<i>Total</i>	<i>14</i>

<i>Senior Year / Spring Semester</i>	<i>Credits</i>
EECE 488. Senior Project II	2
EECE 489. Senior Project II Lab	1
Professional Elective I	3
Technical Elective II	3
General Education (G,P,A,N,H) Requirement	4
<i>Total</i>	<i>13</i>

Total credits – 4 years 127

EE Track in Sustainable Energy Engineering

A track is available for the Electrical Engineering major, in Sustainable Energy Engineering. This is separate from the Watson-level sustainability minor: this track is not a minor, but an alternate track to complete an undergraduate degree in Electrical Engineering.

To pursue the track, a student would take four specific courses in the third and fourth year, which substitute for two core courses and two technical electives. The courses are:

EECE 341, Introduction to Sustainable Energy Engineering

(Taken in place of EECE 332, Semiconductors, Fall junior year)

EECE 342, Energy Storage Systems

(Taken in place of EECE 377, Communications Systems, Spring junior year)

EECE 443, Fundamentals of Power Systems

(Taken as an elective, Fall senior year)

EECE 419, Power Electronics

(Taken as an elective, Fall senior year)

When electing this track, it is necessary to complete all four of the courses to satisfy the graduation requirements for the degree.

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 from their advisor to take other electives, provided a strong case is made.

Technical Electives for EE Majors

- EECE 400 – 485;
- Non-required core courses:
 - EECE 351: Digital Systems Design
 - EECE 359: Computer Communications and Networking

Technical Electives for CoE Majors

- Non-required CS courses: 300 and above;
- EECE 400 – 485;
- Non-required core courses:
 - EECE 323: Electromagnetics
 - EECE 332: Semiconductor Devices
 - EECE 361: Control Systems
 - EECE 377: Communications Systems

Approved Professional Electives for EE and CoE Majors

Any technical elective listed above, and:

ACCT	321 – 475
ASTR	321 – 475
BCHM	321 – 475
BIOL	321 – 475
BME	300 - 499
CHEM	231 – 499
CS	300 – 390, 400 – 472
ECON	321 – 475
EECE	323 – 377 (EE's only)
GEOG	321 – 475
GEOL	321 – 475
ISE	211, 231, 300 – 486
MATH	300 – 386, 400 – 489 (except Math 327 & 447)
ME	211, 273, 274, 300 - 494
MGMT	321 – 475
PHYS	323 – 342, 411 – 474

** Any course not listed as a Technical or Professional Elective requires signed approval from a Faculty Advisor on a Degree Works Exception Form – available from the Watson College Advising Office or the ECE department front office.*

Taking Graduate Courses as an Undergraduate

In their last semester, seniors may have the prerequisites and 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 Graduate Administrative Assistant, 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 *Undergraduate Receiving Graduate Credit: Transcript Notation Petition* form (available from the Financial Aid Office and Student Records or the Graduate School). The form is then filed with the Financial Aid Office and Student Records.

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 College student who wishes to take a course at another institution and use it towards any degree requirement must seek approval from both the department and Watson College Advising Office. Pre-approval on a *Petition to Take Course at Another Institution* form is only required for courses that do not appear on the universities transfer articulation tables. 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 491 (Teaching Practicum), EECE 496 (Industrial Internship), EECE 497 (Independent Study), and EECE 499 (Undergraduate Research) can be used to satisfy the Professional Elective requirement (see full course descriptions in Section VI).

EECE 491 – Teaching Practicum

Students majoring in electrical or computer engineering are encouraged to work with faculty as course assistants in laboratory classes. Normally, near the end of each academic semester, a solicitation for course assistants for the following semester is made. 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. Although the student may enroll for a second teaching practicum, only the first practicum can be counted toward degree requirements. Once the course a student will be assisting in has been determined, the registration into EECE 491 is completed by the ECE front office staff.

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 3 to 4 times the number of credits to match a typical class.

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 toward 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 (W grade mode) 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 in Engineering* form (purple) which can be found at the ECE department front office and on the ECE website under Resources for Current Undergraduate Students. The form requires 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, which will be sent directly to the ECE department for processing. Internships require course registration during the same term or semester as the internship is being completed (i.e., internships completed during the summer months would require summer registration).

Enrollment in EECE 497 and 499

For a student to enroll in an Independent Study or Undergraduate Research section, 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 is to be filled out by the student and signed by the instructor overseeing the specified course. Once done, the form is processed through the ECE front office staff.

Dual Majors or Minors in Electrical and Computer Engineering

Dual Major 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, 359, CS 312, CS 352, Math 314, two additional technical electives, and one additional professional elective.

Minor in Sustainable Engineering – only for engineering majors

Applications are available in the Watson College Advising Office. For the application, additional information, and a list of minor approved elective courses, visit:

<https://www.binghamton.edu/engineering-design/sustainability-minor.html>

Courses, excluding prerequisites, used to fulfill requirements for the major cannot be used as courses satisfying requirements for a minor. However, the courses may be used to satisfy GenEd requirements.

Listed below is a summary of the minor requirements. For EE or CoE students seeking the minor in sustainability, it requires a total of 21 additional credits.

- **Prerequisite Courses** (16 credit hrs.) must be acquired prior to declaring a minor
 - ✓ Math (8 credit hrs.): Differential Calculus (MATH 224), Integral Calculus (MATH 225), Integration Technique & Application (MATH 226), and Infinite Series (MATH 227) (all 2 cr. each)
 - ✓ Chemistry (4 credit hrs.): Chemical Principles (CHEM 111), **OR** Intro Chem Principles I **AND** Intro to Chem Principles II (CHEM 107 and 108)
 - ✓ Physics (4 credit hrs.): General Physics I (PHYS 131)
- **Required Core Courses** (9 credit hrs.)
 - ✓ EDD 305, Introduction to Sustainable Engineering and Design (3 cr.)
 - ✓ EDD 306, Engineering Sustainable Energy (3 cr.)
 - ✓ EDD 307, Ecology for Engineers (3 cr.)
- **Required elective courses** (12 credit hrs.)
 - ✓ Courses must be from at least two different departments and at least two of the elective courses must be at the advanced undergraduate level (i.e., 300 or 400).

Courses required within a student's major other than elective courses CANNOT be used as courses satisfying requirements for the minor.

Study Abroad

The ECE department encourages students to study abroad for a semester, a summer, or shorter period of time. Opportunities well-suited for engineering students may be found at:

<https://www.binghamton.edu/watson/student-services/global-engagement/study-abroad.html>

Please bear in mind, however, that all required junior year core courses must be taken at Binghamton University.

4+1 BS-MS in Electrical and Computer Engineering

A combined **BS and MS** degree program is available for motivated students working toward the BS in electrical or computer engineering at Binghamton University. The MS degree is an excellent professional credential, which usually commands a substantially higher starting salary. The combined-degree program offers the advantage of a simplified admission process, cost saving from double-counted courses, less time to degree completion, and the ability to start employment at the master's level.

Undergraduate students in ECE may apply for admission to the combined-degree program during the **spring semester of their junior year** by submitting a short **department application** form to the ECE Director of Graduate Admissions through email (ningzhou@binghamton.edu). The form is available in the ECE front office and online at <https://www.binghamton.edu/watson/undergraduate/4-plus-1.html>. To apply for admission, undergraduate students must have a GPA of *3.0 or higher* after five semesters (fall semester, junior year):

- (a) students with a GPA above 3.3 may submit the completed department application form (without the need to obtain faculty's signatures of support).
- (b) students with a GPA above 3.0 (but below 3.3) shall obtain two *signatures* of support from ECE faculty on the application form before submitting the application form.

The decision on the department application will be made and sent to the students within ten business days. Once admitted to the program, students may begin taking **graduate courses during their senior year**. Up to two graduate courses taken in the student's senior year can count both toward their MS degree requirements and their senior elective (both professional and technical) requirements (students may not take more than three graduate classes as an undergraduate). A formal **application for Graduate School admission** can be initiated on January 15 of the senior year and must be completed before the end of the **spring semester of the senior year**. Assuming continued good performance of students, the application is only a formality. During their fifth (graduate) year, students in this program must be registered for a total of 21 graduate credits (a total of 7 courses).

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. 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.

4+1 BS-MBA Program

A combined **Bachelor of Science (BS)** and **Master in Business Administration (MBA)** degree program provide Watson undergraduate students with the opportunity to complete their BS degree and MBA degree in five years. In order to complete this program, students will be required to apply during their junior year. Generally, Watson/MBA 4+1 program admission requires a minimum GMAT score of 600, along with a 3.0 GPA in order to advance to the MBA program. During the senior year, students will take three MBA courses (MGMT 501, 502, and 505). These courses will be applied towards fulfilling the technical and/or professional elective component of the engineering undergraduate program. Upon completion of their senior year, students receive their BS degree. In the fifth year they are officially admitted to the MBA program. Additional information can be found on the School of Management website. Advising for the MBA program and courses is provided by SoM, not the ECE department.

VI. ELECTRICAL AND COMPUTER ENGINEERING UNDERGRADUATE COURSES REQUIRED EE and CoE Courses

EECE 212: Linear Algebra & Eng Programming

[4 credits; spring]

An introduction to linear algebra for engineers with computer analysis, visualization, and mathematical programming. Linear algebra topics include matrix operations, systems of linear equations, determinants, solution to matrix equations, vector space, eigenvalues and eigenvectors. Introduction to engineering programming includes variables and arrays, matrix operation, functions, data representation, user defined functions and a brief introduction on graphical programming. Engineering applications such as the matrix representation of graphs, matrices applied to electric circuits and linear systems will be introduced during the class. Laboratory exercises.

Prerequisite: Calculus I

EECE 251: Digital Logic Design

[4 credits; fall]

Fundamental and advanced concepts of digital logic. Boolean algebra and functions. Design and implementation of combinational 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. There is a \$215 fee associated with this course.

EECE 260: Electric Circuits

[4 credits; spring]

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. There is a \$25 fee associated with this course.

Prerequisite: PHYS 132

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.

EECE 287: Sophomore Design

[4 credits; spring]

Design-based introduction to embedded computer systems. Organization and composition of computer processors, memory, and peripherals. Introduction to assembly-language and embedded C programming. Design of hardware and software for embedded processor applications. Laboratory exercises and design projects. There is a \$45 fee associated with this course.

Prerequisites: CS 211 and EECE 251

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 212, EECE 260 and MATH 324

EECE 315: Electronics I

[4 credits; fall]

Introduction to 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. There is a \$35 fee associated with this course.

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.

EECE 387: EECE Design Lab

[4 credits; spring]

This course provides experience with the engineering design process, which spans significant areas of electrical and computer engineering. Lecture will focus on various aspects of the design process as well as discussion of component characteristics. There is a \$25 fee associated with this course.

EE Prerequisites: EECE 301 and EECE 315

CoE Prerequisites: EECE 315 and EECE 351

EECE 487: Senior Project I concurrent with

EECE 486: Senior Project I Lab

[3 credits; fall]

Design projects in cooperation with local industry, other external clients, and university sponsored projects – outlining specifications, proposals, time schedules, and paper designs. Periodic design reviews with client, written and oral progress reports, and final presentation. Evaluation based on individual and team performance. There is a \$250 fee associated with this course.

Prerequisites: EECE 387 and Senior Standing

EECE 488: Senior Project II concurrent with

EECE 489: Senior Project II Lab

[3 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. There is a \$250 fee associated with this course.

Prerequisites: EECE 487 or consent of Instructor

EE REQUIRED Courses / CoE Electives

EECE 323: Electromagnetics

[4 credits; spring] Physics and applications of electromagnetic fields as encapsulated in the vector form of Maxwell's equations. Static electrical and magnetic fields, time-varying electromagnetic fields, Poisson's equations, fundamental laws of electromagnetic fields (including Gauss's law, Ampere's law, Faraday's law, and Biot-Savart's law), time-harmonic fields, wave propagation, and transmission lines. Numerical techniques.

Prerequisites: EECE 260 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; and fabrication.

Prerequisite: PHYS 132

Corequisite: EECE 315

EECE 341: Introduction to Sustainable Energy Engineering

[3 credits; spring; course for track in Sustainable Energy Engineering]

This course explores sustainable energy systems by examining fossil fuel impacts on climate and the limitations of traditional energy generation, including coal, natural gas and nuclear. It covers renewable sources of solar and wind, with detailed analysis of photovoltaic and wind power systems from physical principles at the device level to grid integration. Energy storage technologies are evaluated by time and capacity scales. Power transmission challenges and the electrification of buildings and transportation are also addressed. Throughout, students consider global energy resources, economic factors, and technical design to understand the future of energy systems. Students learn practical engineering practices through completion of a group project.

Prerequisite: CHEM 111 and PHYS 132

EECE 342: Energy Storage Systems

[3 credits; spring; course for track in Sustainable Energy Engineering]

This course provides a comprehensive study of energy storage systems, with a primary focus on batteries. It covers various battery types, their chemistries, operational characteristics, and applications in renewable energy systems, electric vehicles, and portable devices. The course also includes battery management systems, electronics relevant to storage applications, safety considerations, and the environmental impact of battery technologies.

Prerequisite: EECE 341

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 static 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.

Prerequisite: a grade of C or better in 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. There is a \$60 fee associated with this course.

Prerequisite: EECE 251

EECE 359: Computer Communications and Networking

[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 integrity, error detection and error control, forward error correction; 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 I

[3 credits; fall]

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, information security, and mathematical basis of encryption. Cryptanalysis (code breaking), modern block and stream ciphers, public-key cryptography, protocols, security engineering and threat management. Technical elective.

Prerequisites: ISE 261 or MATH 327 and CS 211

EECE 407: Network Computer Security

[3 credits; fall and spring]

Key topics in network and host level security. Introduction to practical aspects of networking in physical and virtual environments. Lab exercises using enterprise-level networking equipment, such as switches, routers, and firewalls. Common attacks on computer networks and defense mechanisms. Deployment, detection and mitigation of common attacks using a variety of software tools. Technical elective.

Prerequisite: Programming skills (preferably Python)

EECE 414: Software-Defined Radio

[3 credits; spring]

This course explores and analyzes the individual elements required to design a software-defined radio (SDR) receiver. Optimizations and tradeoffs are discussed as the receiver elements are integrated together. For the final project, the functional elements are integrated into a digital receiver system and the performance of the receiver is assessed. Topics include: modulation and demodulation, signal sampling, pulse shaping, bandwidth and data rate, synchronization, linear equalization, coding and decoding, timing recovery, and carrier recovery. Matlab is used to model the receiver elements and to implement the final project. Technical elective.

Prerequisites: EECE 359 or EECE 377 or equivalent

EECE 416: Analog Circuit Design

[3 credits; fall]

Introduction to analog circuit design. Course topics include large and small-signal analysis, circuit characteristics (gain, input/output resistance, etc.), amplifier structures, frequency/time response, feedback and stability, multistage amplifier and active filters. This course includes several assignments requiring the use of software tools for circuit simulation. Technical elective.

Prerequisite: EECE 315

EECE 418: Power Systems I: Equipment and Power Flow

[3 credits; fall]

The purpose of this course is to form a solid basis for analyzing power systems. The course gives an overview of a power system and is focused on the basic concepts and elements that are essential in power system planning, operation and control. The course introduces modeling methods for major components in a power system and the methods for solving power flow problems. Specifically, the course addresses the following topics: an overview of power system and structure of electric power industry; the 3 phase circuits in power systems; steady state modeling of generators and transformers; transmission line modeling; power flow analysis. Technical elective.

Prerequisites: EECE 260 and EECE 323 or approval of instructor

EECE 419: Power Electronics

[3 credits; fall]

Electronic processing of electrical energy. Overview of power electronics devices such as DMOSFET, IGBT and Thyristor. 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. Technical elective.

Prerequisites: EECE 260, EECE 301 and EECE 323

EECE 423: Power Systems II: Protection and Control

[3 credits; spring]

The purpose of this course is to continue developing basic skills for analyzing electric power systems. The course gives an overview of a power system and is focused on problems and analysis methods that are essential in power system planning, operation, and control. Specifically, the course addresses the following topics: an overview of power system and structure of electric power industry; basics of fault analysis and protection systems; generator transients; basics of stability concepts and stability analysis; basics of load frequency control, automatic generation control, and voltage control. Technical elective.

Prerequisite: EECE 418

EECE 431: Introduction to Microfabrication

[4 credits; spring]

Multidisciplinary Introduction to Microfabrication: Introduction to clean room tools, procedures, and theory through the fabrication and characterization of various devices from the fields of electrical engineering, mechanical engineering, physics and chemistry. Fabrication of the devices will cover most clean room tools and techniques, including lithography based patterning methodologies; chemical vapor deposition; sputtering; thermal and e-beam evaporation; thermal oxidation; reactive ion etching; ion implantation; and wet chemical processing. The accompanying lecture will cover the theory of the tools used. Technical elective. There is an \$86 fee associated with this course.

Prerequisite: EECE 332 or an equivalent course in basic semiconductor device physics

EECE 432: Physics & Tech of Solar Cells

[3 credits; spring]

This course focuses on the science and engineering fundamentals of photovoltaic solar energy devices and systems. The lectures cover solar radiation, semiconductor properties, p-n junction theory, solar cell operating principles, solar cell 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 covers solar module interconnections, engineering design of solar electricity systems, and power conditioning at the systems level. Technical elective.

Prerequisite: EECE 332 or equivalent is desirable but not essential

EECE 433: Advanced Semiconductor Lasers

[3 credits; offered every third semester]

Physics, device structure, and operation of semiconductor lasers. Band structure in solids, optical processes in semiconductors, p-n junctions, and quasi-Fermi levels; rate equation model for semiconductor lasers, static and dynamic characteristics; characteristics of distributed feedback, Bragg reflector, vertical cavity and Fabry-Perot lasers. Technical Elective.

Prerequisite: EECE 332

EECE 438: System on a Chip Design

[3 credits; spring]

This course will provide an overview of the components of system-on-a-chip (SOC) design from initial technology and architectural choices, to hardware/software design techniques (e.g., data/control flow modeling and implementation, embedded cores and coprocessors, hardware/software communication), as well as 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). Technical elective.

Prerequisites: EECE 287 and EECE 315

EECE 443: Fundamentals of Power Systems

[3 credits; fall; course for track in Sustainable Energy Engineering]

This course traces the development of electric power systems from early experiments with electricity to today's digital, decentralized energy network. Through historical and global lens, with a focus on New York State's involvement, the course will explore how electric grids were developed, operated, and transformed. Students will engage with key inventions, historical figures, policy shifts, and societal impacts of electrification. Renewable systems modeling, control system design, power systems analysis techniques, and power system simulation tools will be introduced along with the historical developments.

Prerequisite: EECE 341

EECE 451: Digital Systems Design II

[3 credits; fall]

VLSI design, synthesis and test using hardware description language (HDL) at the register-transfer level (RTL). HDL programming and simulation basics, followed by advanced HDL programming for synthesis and test benching. Principles of RTL synthesis introduced. Design and synthesis of digital systems to meet constraints. Pre-synthesis and post-synthesis verification using simulation. Commercial synthesis tool discussed in detail. Technical elective.

Prerequisite: EECE 351

EECE 452: Computer Design

[3 credits; fall]

This course will cover several topics in the area of computer architecture. We will discuss various concepts behind the designs of current microprocessors. In particular, the topics that will be covered in the course are: RISC machines and instruction set architectures, performance evaluation, pipelined architecture, static and dynamic scheduling, instruction-level parallelism, advanced pipelining, speculative execution, memory hierarchy and organization, multi-processing, compiler techniques (and more). Technical elective.

Prerequisite: EECE 351 or equivalent

EECE 453: Computer Network Architecture

[3 credits; fall]

This is an introduction level computer network architecture course for senior/graduate students. The goal is to provide the students with a comprehensive picture of the technologies behind the internet and applications on top of it. Starting with a brief review of some basics of networking, we will discuss from the lowest levels of packet transmissions through the highest levels of application software, under the umbrella of the TCP/IP architecture. Emphasis will be given on network architecture, components and design issues. Technical elective.

Prerequisite: Basic knowledge of probability and statistics

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. Technical elective.

Prerequisite: EECE 351

EECE 457: Fundamentals of Computer Security

[3 credits; spring]

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

Prerequisites: EECE 287 or CS 211; familiarity with C or C++ or similar programming language

EECE 458: Embedded Systems Design

[3 credits; fall]

Microcontroller based embedded systems design and analysis. Bare metal assembly and C software development for hardware and software integration. Driver based hardware abstraction and input/output synchronization. Sensor hardware integration, information extraction and fusion. Microcontroller applications and project. Technical elective.

Prerequisites: EECE 251, EECE 315, and CS 211 or equivalent

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; every other fall]

Electro-optic devices and systems. Blackbody, LED and laser sources, photodetectors, 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; digital passband modulation and demodulation; channel coding; error detection; spread spectrum; signal space representation; bit error rate. Technical elective.

Prerequisite: EECE 377 or equivalent

EECE 480: Special Topics in ECE

(*alpha series, i.e., 480A, 480B, etc.*)

[3 credits; fall/spring]

Topics in electrical/computer engineering that vary from year to year. If applicable, may be run every fall or spring semester. See semester schedule for current offering.

EECE 491: Teaching Practicum

[variable credit; every semester]

Assist with undergraduate instruction of a formal course under the direct supervision of the course instructor. May count for one professional elective but may not be used to satisfy a technical elective unless significant work is done and always at the discretion of the Chair or Undergraduate Director. Taken with normal (letter) grade option ONLY; NOT P/F or S/U.

Prerequisite: permission of course instructor

EECE 496: Industrial Internship

[variable credit; 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. Internships require course registration during the same term or semester as the internship is being completed (e.g., internships completed during the summer months would require summer registration). Taken with normal (letter) grade option ONLY; NOT P/F or S/U.

Prerequisite: permission of faculty sponsor for internship

EECE 497: Independent Study

[variable credit; every semester]

Individual study under direct supervision of a faculty member. Approval of proposed subject by the faculty member and plan of study must be obtained prior to registration. Can be used to satisfy either a technical or professional elective. If used to satisfy a technical or professional elective, it must be taken with normal (letter) grade option ONLY; NOT P/F or S/U.

EECE 499: Undergraduate Research

[variable credit; every semester]

Assist with faculty research. Approval of proposed subject by the faculty member and plan of research must be obtained prior to registration. Can be used to satisfy either a technical or professional elective. If used to satisfy a technical or professional elective, it must be taken with normal (letter) grade option ONLY; NOT P/F or S/U.

VII. WATSON College STUDENT ORGANIZATIONS

All Watson College 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:

- Alpha Omega Epsilon
- Engineers Without Borders
- Eta Kappa Nu (electrical engineering honor society)
- Girls Who Code
- HackBU

- Institute of Electrical and Electronics Engineers (IEEE)
- National Society of Black Engineers (NSBE)
- Society of Asian Scientists and Engineers (SASE)
- Society of Hispanic Professional Engineers (SHPE)
- 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)
- Watson Combat Robotics League
- Women in Tech

A complete list can be found on the Watson College Services website.

VIII. CONTACT INFORMATION

Binghamton University General Contacts

Undergraduate Admissions	777-2171	admissions.binghamton.edu
Financial Aid Office	777-2428	bingfa.binghamton.edu
Student Records	777-6088	registrar.binghamton.edu
Student Accounts	777-2702	studentaccounts.binghamton.edu
Watson College Student Services, EB-M00	777-6203	watson.binghamton.edu
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