



VirginiaTech

College of Engineering

The Bradley Department of Electrical and  
Computer Engineering  
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October 23<sup>rd</sup>, 2017

To: University Registrar

From: Jaime De La Ree, ECE Assistant Department Head

Re: CPE Degree, Controls, Robotics & Autonomy Major

The Department of Electrical and Computer Engineering is currently in the process of seeking approval for the addition of 12 new majors/checksheets to our BSEE and BSCPE degrees. These options will allow our students more flexibility and specialization within ECE. In accordance to the guides and directives of SCHEV each of the new 12 requested majors (7 in EE and 5 in CpE) includes a minimum of 25% of common credit-hours under each degree.

Attached for your review/approval is the graduation checksheet for students graduating in calendar year 2020 with a Bachelor of Science Degree in Computer Engineering – Major in Control, Robotics and Autonomy.

This is a new checksheet for this Major based on the Computer Engineering Degree checksheet of 2019.

The ECE Department does not request any additional resources for this Major.

Please do not hesitate to contact me if any questions and/or comments arise.



January 31<sup>st</sup>, 2018

UCC  
CUSP

Re: EE/CPE Majors

### **Justification/Need for Major**

During the past 40 years the Electrical and Computer Engineering (ECE) Department has grown from a group of about 30 faculty members to a research/teaching active group of more than 100. Simultaneously, the scope of the research and teaching requirements of the ECE have dramatically expanded to include a wide variety of new technologies and expertise such as: photonics, machine learning, power electronics, and many more. To better address these expanded educational requirements, the ECE Department has developed 12 new majors—7 under the Electrical Engineering (EE) degree and 5 under the Computer Engineering (CPE) degree.

The creation of these new majors within the EE and CPE degrees will provide an opportunity for ECE students to choose educational paths that are better aligned with well-established technical areas in industry and academia. As such, we believe these majors will improve the marketability of our graduating seniors without the sacrifice of academic rigor. Students in both degrees will cover a common background (25% or greater of the program credit-hours) and will subsequently select a major aligned with an area of technical expertise. Please note that the ECE department will continue to offer traditional EE and CPE degree with no major concentration for those students that wish to obtain the traditional degree.

### **Strategic Plan**

Constituents and stakeholders of the ECE Department at Virginia Tech have provided input and support to the ideas behind the creation of our Majors. Our Industrial Advisory Board discussed, provided input and supported the initiative. Many of the recruiting teams that approach our department in search of our graduating students have indicated and made requests with, many times, specific knowledge out of our undergraduate programs.

### **Students Served**

Currently the ECE Department at Virginia Tech is receiving between 450 and 530 sophomores per academic year. After one year of core courses that support our more advanced courses the students will be able to select specific areas of expertise. Nowadays, those students would be enrolling our Senior Technical Elective and Design Technical Elective courses. Most of the courses that are in

our Junior and Senior years will be used to support the requested Majors. The past enrollment is and will continue to be the best indication of the students served by the proposed Majors.

### **Resources Needed**

The new Majors Checksheets incur only a reorganization and revision of mostly present courses in our EE and CPE Degree. Therefore, no new resources will be required for the implementation of the Majors at this time.

COLLEGE OF ENGINEERING  
BRADLEY DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING  
**BACHELOR OF SCIENCE IN COMPUTER ENGINEERING**  
**CONTROLS, ROBOTICS & AUTONOMY MAJOR**  
FOR STUDENTS GRADUATING IN CALENDAR YEAR 2020  
131 CREDITS REQUIRED FOR GRADUATION

FALL SEMESTER FRESHMAN 2016		Credits	SPRING SEMESTER FRESHMAN 2017		Credits
CHEM 1035 General Chemistry Co: MATH 1025 or 1225		3	ENGL 1106 First-Year Writing Pre: ENGL 1105		3
CHEM 1045 General Chemistry Lab Co: CHEM 1035		1	MATH 1226 Calculus of a Single Variable Pre: MATH 1225		4
ENGL 1105 First-Year Writing		3	PHYS 2305 Foundations of Physics I Co: PHYS 2325 or MATH 1206 or MATH 1206H or MATH 1226 Pre: MATH 1205 or MATH 1205H or MATH 1225 or MATH 1206 or MATH 1206H or MATH 1226		4
MATH 1225 Calculus of a Single Variable (C-) Pre: Math Ready		4	ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215		2
ENGE 1215 Foundations of Engineering (C-) Co: MATH 1225		2	ECE 1574 <sup>(1)</sup> Engineering Problem Solving w/C++ (C-) Pre: ENGE 1024 or ENGE 1215, (MATH 1205 or MATH 1205H or MATH 1225)		3
CLE (Area 2, 3, or 7)		3	MATH 1114 Elementary Linear Algebra <b>OR</b> MATH 2114 Introduction to Linear Algebra Pre: MATH 1226 or a grade of at least B in MATH 1225		2-3
<b>TOTAL</b>		<b>16</b>	<b>TOTAL</b>		<b>18-19</b>
FALL SEMESTER SOPHOMORE 2017		Credits	SPRING SEMESTER SOPHOMORE 2018		Credits
MATH 2214 Introduction to Differential Equations (C-) Pre: 1114 or 1114H or 2114 or 2114H, (1206 or 1226)		3	MATH 2204 Introduction to Multivariable Calculus Pre: MATH 1226		3
PHYS 2306 Foundations of Physics I (C-) Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305		4	MATH 2534 Introduction to Discrete Math Pre: CS 1114 or ECE1574		3
ECE 2014 <sup>(1)</sup> Engineering Professionalism in ECE (C-) Pre: Sophomore standing, Co: 2004 or 2504		2 <sup>[F,S]</sup>	ECE 2004 <sup>(1)</sup> Electric Circuit Analysis (C-) Pre: ENGE 1216; Co: MATH 2214		3 <sup>[F,S,SI]</sup>
ECE 2504 <sup>(1)</sup> Introduction to Computer Engineering (C-) Pre: 1574		3 <sup>[F,S,SI]</sup>	ECE 2074 <sup>(1)</sup> Electric Circuit Analysis Laboratory (C-) Pre: ENGE 1216; Co: 2004, MATH 2214		1 <sup>[F,S,SI]</sup>
ECE 2574 <sup>(2)</sup> Data Structures and Algorithms (C-) Pre: 1574		3 <sup>[F,S,SI]</sup>	ECE 2534 <sup>(1)</sup> Microcontroller Programming and Interfacing (C-) Pre: 2504		4 <sup>[F,S]</sup>
CLE (Area 6)		1	CLE (Areas 2, 3, or 7)		3
<b>TOTAL</b>		<b>16</b>	<b>TOTAL</b>		<b>17</b>
FALL SEMESTER JUNIOR 2018		Credits	SPRING SEMESTER JUNIOR 2019		Credits
ECE 2204 <sup>(1)</sup> Electronics (C-) Pre: 2004(C-)		3 <sup>[F,S,SI]</sup>	ENGL 3764 Technical Writing Pre: Junior standing		3
ECE 2274 <sup>(1)</sup> Electronic Networks Laboratory I (C-) Pre: 2074; Co: 2204		1 <sup>[F,S,SI]</sup>	ISE 2014 Engineering Economy Pre: ENGE 1024 or ENGE 1215 or BC 1224		2
ECE 2704 <sup>(1)</sup> Signals and Systems (C-) Pre: (2004 or 2004H), 2074, (MATH 2214 or MATH 2214H)		3 <sup>[F,S,SI]</sup>	Controls, Robotics & Autonomy Technical Elective from list		3
STAT 4714 Probability & Statistics for EE Pre: MATH 2224 or MATH 2204		3	ECE 2500 <sup>(2)</sup> Computer Organization and Architecture Pre: 2504		3 <sup>[F,S]</sup>
ECE 3574 <sup>(2)</sup> Applied Software Design (C-) Pre: 2574		3 <sup>[F,S]</sup>	ECE 4704 <sup>(2)</sup> Principles of Robotics Systems (C-) Pre: (2704, STAT4714) or (ME3514, STAT3704)		3 <sup>[S]</sup>
CLE (Areas 2, 3, or 7)		3	ECE 3714 <sup>(2)</sup> Introduction to Controls Systems Pre: 2704		3 <sup>[S]</sup>
<b>TOTAL</b>		<b>16</b>	<b>TOTAL</b>		<b>17</b>
FALL SEMESTER SENIOR 2019		Credits	SPRING SEMESTER SENIOR 2020		Credits
ECE 4534 <sup>(1)</sup> Embedded System Design Pre: 3574, 2534, 2014		4 <sup>[F,S]</sup>	Controls, Robotics & Autonomy Technical Elective from List		3
Controls, Robotics & Autonomy Design Technical Elective from List		3	ECE 4524 <sup>(2)</sup> Artificial Intelligence and Engineering Applications, Pre: 2574, STAT 4714.		4 <sup>[S]</sup>
ECE4580 <sup>(2)</sup> Digital Image Processing		3 <sup>[F]</sup>	Engineering and Science Elective from List		3
Controls, Robotics & Autonomy Technical Elective from list		3	CLE (Areas 2, 3, or 7)		3
CLE (Areas 2, 3, or 7)		3	Free Elective		1-2
<b>TOTAL</b>		<b>16</b>	<b>TOTAL</b>		<b>14-15</b>

**General Information about Checksheet:** Superscripted annotation after the course number (1) indicates core course of the degree while (2) indicates courses associated with the major. Additionally, (F, S, SI, SII) in credits column indicates terms when a course is expected to be offered. Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

### Curriculum for Liberal Education (CLE)

Consult the CLE Alphabetical Listing at: <http://www.cle.prov.vt.edu/guides/alpha.html>, CLE courses need to be completed prior to graduation.

CLE Area 1: Writing and Discourse (6 hrs)	<b>ENGL 1105</b>	<b>(3)</b>	<b>ENGL 1106</b>	<b>(3)</b>
CLE Area 2: Ideas, Cultural Traditions, Values Electives (6 hrs)		<b>(3)</b>		<b>(3)</b>
CLE Area 3: Society & Human Behavior electives (6 hrs)		<b>(3)</b>		<b>(3)</b>
CLE Area 4: Scientific Reasoning and Discovery (8 hrs)	<b>PHYS 2305</b>	<b>(4)</b>	<b>PHYS 2306</b>	<b>(4)</b>
CLE Area 5: Quantitative and Symbolic Reasoning (8 hrs)	<b>MATH 1225</b>	<b>(4)</b>	<b>MATH 1226</b>	<b>(4)</b>
CLE Area 6: Creativity & Aesthetic Experience elective (1 hr)				<b>(1)</b>
CLE Area 7: Global Issues Elective (3 hrs)				<b>(3)</b>

If a CLE course is double-counted to satisfy two different CLE areas, a free elective(s) must be taken to maintain a minimum of 131 credits.

### Electives

The CPE degree with a Major in Controls, Robotics & Autonomy requires 3 hours of Controls, Robotics & Autonomy design technical electives from list, 9 hours of Controls, Robotics & Autonomy technical electives from list, 3 hours of engineering and science electives from list, and 1-2 hours of free electives. Free electives or Area 6 courses offered only on a P/F basis may be taken under the P/F grading option.

**Change of Major Requirements:** For Change of Major requirement, please see:

<http://www.enge.vt.edu/undergraduate/undergraduate-changing-majors>

**Foreign Language Requirements:** Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

**Satisfactory Progress Towards Degree:** University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for Computer Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Additionally, upon attempting of 60 credits, CPE students must have satisfactorily completed ECE 2014, ECE 2504 or 2574, MATH 2214 and (2204 or 2534), and PHYS 2306
- Upon attempting of 90 credits, CPE students must have successfully completed 35 credits of in-major courses and have 2.0 overall and in-major GPAs. (In determining the CPE in-major GPA, all ECE courses, including repeats, are used).

**Statement of Hidden Prerequisites:** Pre-requisites for each course are listed after the course title. All ECE courses required a C- or better in prerequisite courses. There are no hidden pre-requisites in this program of study.

**Graduation Requirements:** Each student must complete at least 131 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00.

**TECHNICAL ELECTIVES FOR  
COMPUTER ENGINEERING UNDERGRADUATES  
Controls Robotics & Autonomy  
Graduating 2020**

The courses listed below are approved for CpE in-major and non-major technical elective credit. **Actual course offerings will be based on sufficient resources, including faculty availability and student demand.** Refer to the University's on-line timetable of classes for specific course availability information.

**In-Major Technical Electives**

Courses are grouped according to their inter-relatedness, but students are free to choose from multiple groups. If you are unsure of an academic focus, you are encouraged to take courses from several groups, giving you a broader background.

**COMPUTERS (from ECE Department. DTE indicates Design Technical Elective)**

- ECE3544 (4) DIGITAL DESIGN I, Pre: 2504, C- or better, Pre: 2204 or MSE 3204.
- ECE4424 (3) MACHINE LEARNING (CS 4824), Pre: 2574, (STAT 4604 or STAT 4705 or STAT 4714).
- ECE4504 (3) COMPUTER ORGANIZATION (CS 4504), Pre: 2504 or CS 3214.
- ECE4514 (4) DIGITAL DESIGN II, Pre: 3544. **DTE**
- ECE4520 (3) DIGITAL AND MIXED-SIGNAL SYSTEM TESTING AND TESTABLE DESIGN, Pre: 2574, (3504 or 3544).
- ECE4525 (3) VIDEO GAME DESIGN AND ENG, Pre: 3574. **DTE**
- ECE4526 (3) VIDEO GAME DESIGN AND ENG, Pre: 4525. **DTE**
- ECE4530 (3) HARDWARE-SOFTWARE CODESIGN, Pre: 2534, (3504 or 3544). **DTE**
- ECE4534 (4) EMBEDDED SYSTEM DESIGN, Pre: 2014, 2534, 3574.
- ECE4540 (3) VLSI CIRCUIT DESIGN, Pre: 2204, 2504. **DTE**
- ECE4550 (3) REAL-TIME SYSTEMS, Pre: 4534 or CS 3214. **DTE**
- ECE4554 (3) INTRODUCTION TO COMPUTER VISION, Pre: 3574, (STAT 4705 or STAT 4714).
- ECE4560 (3) COMPUTER AND NETWORK SECURITY FUNDAMENTALS, Pre: 4564 or CS 3214. **DTE**
- ECE4564 (3) NETWORK APPLICATION DESIGN, Pre: 2504, 2574. **DTE**
- ECE4570 (3) WIRELESS NETWORKS AND MOBILE SYSTEMS (CS 4570), Pre: 4564. **DTE**
- ECE4574 (3) LARGE-SCALE SOFTWARE DEVELOPMENT FOR ENGINEERING SYSTEMS, Pre: 3574. **DTE**
- ECE4580 (3) DIGITAL IMAGE PROCESSING.

**COMPUTERS (from CS Department)**

NOTE: The Computer Science Department restricts some of its courses to CS majors. Contact the CS department to follow their force-add procedure. CS requires a C or better in all in-major (CS or ECE) prerequisite courses. CS may accept some ECE courses as prerequisite substitutions. See the CS advisors in 114 McBryde for any clarification of prerequisite requirements. Note that many CS courses are taught in Java. If you use an ECE course as prerequisite, you will be expected to be proficient in Java before entering these upper level courses.

- CS 3114 (3) DATA STRUCTURES AND ALGORITHMS, Pre: CS 2114, CS 2505, MATH 2534
- CS 3214 (3) COMPUTER SYSTEMS, Pre: CS 2506, CS 2114.
- CS 3304 (3) COMPARATIVE LANGUAGES, Pre: CS 3114.
- CS 3414 (3) (MATH 3414) NUMERICAL METHODS, Pre: (CS 1044 (C) or CS 1705 (C) or CS 1114 (C) or CS 1124 (C)), (Math 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)
- CS 3714 (3) MOBILE SOFTWARE DEVELOPMENT, Pre: CS 2114.

- CS 3744 (3) INTRO GUI PROGRAMMING/GRAPHICS, Pre: CS 2114, (MATH 1114 or MATH 1114H or MATH 2114 or MATH 2114H), (MATH 1224 or MATH 1224H or MATH 2204 or MATH 2204H).
- CS 3824 (3) INTRODUCTION TO COMPUTATIONAL BIOLOGY AND BIOINFORMATICS, Pre: CS 3114.
- CS 4104 (3) DATA AND ALGORITHM ANALYSIS, PRE: CS 3114, MATH 3134 or MATH 3034.
- CS 4114 (3) INTRODUCTION TO FORMAL LANGUAGES AND AUTOMATA THEORY, Pre: MATH 3134 or MATH 3034.
- CS 4124 (3) THEORY OF COMPUTATION, Pre: MATH 3134 or MATH 3034.
- CS 4204 (3) COMPUTER GRAPHICS, Pre: CS 3114, CS 3744.
- CS 4214 (3) SIMULATION AND MODELING, Pre: CS 2114.
- CS 4234 (3) PARALLEL COMPUTATION, Pre: CS 3214.
- CS 4244 (3) INTERNET SOFTWARE DEVELOPMENT, Pre: CS 3214.
- CS 4254 (3) COMPUTER NETWORK ARCHITECTURE AND PROGRAMMING, Pre: CS 3214.
- CS 4264 (3) PRINCIPLES OF COMPUTER SECURITY, Pre: CS 3214 or (ECE 2500, ECE 3574).
- CS 4304 (3) COMPILER DESIGN AND IMPLEMENTATION, Pre: CS 3214.
- CS 4414 (3) (MATH 4414) ISSUES IN SCIENTIFIC COMPUTING, Pre: (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006), MATH 3214, (CS 2114 or MATH 3054).
- CS 4604 (3) INTRODUCTION TO DATA BASE MANAGEMENT SYSTEMS, Pre: CS 3114.

#### **COMMUNICATIONS**

- ECE3604 (3) INTRODUCTION TO RF & MICROWAVE ENGINEERING, Pre: 2004, 3105.
- ECE3614 (3) INTRODUCTION TO COMMUNICATION SYSTEMS, Pre: 2704, STAT 4714.
- ECE4605 (3) RADIO ENGINEERING, Pre: 2014, 3105, 3204, 3614.
- ECE4606 (3) RADIO ENGINEERING, Pre: 4605.
- ECE4614 (3) TELECOMMUNICATION NETWORKS, Pre: 2504, 2704, STAT 4714.
- ECE4624 (3) DIGITAL SIGNAL PROCESSING AND FILTER DESIGN, Pre: 2014, 3704.
- ECE4634 (3) DIGITAL COMMUNICATIONS, Pre: 3614, STAT 4714.
- ECE4644 (3) SATELLITE COMMUNICATIONS, Pre: 3614.
- ECE4664 (1) ANALOG & DIGITAL COMMUNICATIONS LABORATORY, Pre: 3614. Co: 4634
- ECE4675 (1) RADIO ENGINEERING LABORATORY, Pre: 3106, 3204. Co: 4605.
- ECE4676 (1) RADIO ENGINEERING LABORATORY, Pre: 4675. Co: 4606.

#### **ELECTROMAGNETICS**

- ECE3104 (3) INTRODUCTION TO SPACE SYSTEMS AND TECHNOLOGIES, Pre: 2204, 3105.
- ECE3105 (3) ELECTROMAGNETIC FIELDS, Pre: PHYS 2306, (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H), (ECE 2004 or ECE 2004H).
- ECE3106 (3) ELECTROMAGNETIC FIELDS, Pre: 3105.
- ECE3134 (3) INTRODUCTION TO OPTOELECTRONICS, Pre: 3105.
- ECE3154 (1) SPACE SYSTEMS LAB, Pre: 3105. Co: 3104.
- ECE3174 (1) OPTOELECTRONICS LAB, Pre: 2274. Co: 3134.
- ECE4104 (4) MICROWAVE AND RF ENGINEERING, Pre: 3106, 3204, 2014.

- ECE4114 (3) ANTENNAS, Pre: 3106, 2014.
- ECE4124 (3) RADIO WAVE PROPAGATION, Pre: 3106.
- ECE4134 (3) PHOTONICS, Pre: 3106.
- ECE4144 (3) OPTICAL SYSTEMS, Pre: 3106.
- ECE4154 (3) INTRODUCTION TO SPACE WEATHER, Pre: 3106.
- ECE4164 (3) INTRODUCTION TO GLOBAL POSITIONING SYSTEM (GPS) THEORY AND DESIGN, Pre: 2014, (3106 or AOE 4134).
- ECE4194 (3) ENGINEERING PRINCIPLES OF REMOTE SENSING, Pre: 3106.

#### **CIRCUITS/ELECTRONICS**

- ECE3004 (3) AC CIRCUIT ANALYSIS, Pre: 2704.
- ECE3074 (1) AC CIRCUIT ANALYSIS LABORATORY, Pre: 2074. Co: 3004.
- ECE3204 (3) ANALOG ELECTRONICS, Pre: 2204, 2704. Co: 3274.
- ECE3214 (3) SEMICONDUCTOR DEVICE FUNDAMENTALS
- ECE3274 (1) ELECTRONIC CIRCUITS LABORATORY II, Pre: 2274, 3074. Co: 3204.
- ECE4205 (3) ELECTRONIC CIRCUIT DESIGN, Pre: 3204.
- ECE4206 (3) ELECTRONIC CIRCUIT DESIGN, Pre: 2014, 4205.
- ECE4220 (3) ANALOG INTEGRATED CIRCUIT DESIGN, Pre: 3204.
- ECE4224 (3) POWER ELECTRONICS, Pre: 3204, 2014.
- ECE4234 (3) SEMICONDUCTOR PROCESSING, Pre: 2204 or 3054.
- ECE4244 (3) INTERMEDIATE SEMICONDUCTOR PROCESSING LABORATORY, Pre: 2014, (4234 or MSE 4234).
- ECE4284 (1) POWER ELECTRONICS LABORATORY, Co: 4224.

#### **POWER SYSTEMS**

- ECE3304 (3) INTRODUCTION TO POWER SYSTEMS, Pre: 3004.
- ECE3354 (1) ELECTRIC POWER ENGINEERING LABORATORY, Co: 3304.
- ECE4304 (3) DESIGN IN POWER ENGINEERING, Pre: 2014, 3304.
- ECE4334 (3) POWER SYSTEM ANALYSIS AND CONTROL, Pre: 3304.
- ECE4344 (3) ELECTRIC POWER QUALITY FOR THE DIGITAL ECONOMY, Pre: 3304.
- ECE4354 (3) POWER SYSTEM PROTECTION, Pre: 4334.
- ECE4364 (3) ALTERNATE ENERGY SYSTEMS, Pre: STAT 4714.
- ECE4374 (1) POWER SYSTEM PROTECTION LABORATORY, Pre: 4334. Co: 4354.

#### **SYSTEMS/CONTROLS**

- ECE3704 (3) CONTINUOUS AND DISCRETE SYSTEM THEORY, Pre: 2704.
- ECE4704 (3) PRINCIPLES OF ROBOTICS SYSTEMS, Pre: (2574, STAT 4714) or (ME 3514, STAT 3704).
- ME 4735 (3) MECHATRONICS, Pre: (ECE2204, ECE2704) or (ECE 3254, ME 3514).
- ME 4736 (3) MECHATRONICS, Pre: ME 4735.

(ME courses are typically restricted to ME students and will need to be force-added through the ME Advising office.)



## ELECTRICAL AND COMPUTER SENIOR DESIGN PROJECT

A two-semester design project, emphasizing systems engineering principles in the development of an electrical and/or computational system. A specific, substantial engineering design problem is taken from problem definition to system realization and testing to demonstrate meeting of design specifications. This represents a major design experience based on knowledge and skills acquired in earlier course work throughout the curriculum. **Note: both semesters must be completed to earn credit.**

ECE4805 (3) SENIOR DESIGN PROJECT, Pre: 4805: Electrical Engineering majors must have completed the following courses with a C- or better: 2014, 2534, and any 2 of the following courses: (3105, 3204, 3304, 3614, 3704). Computer Engineering majors must have completed the following courses with a C- or better: 2014, 2534, 3574 and one of the following courses: (3204 and 3274, 3004 and 3074, 3544, 3614, 3704, 3714, 4424, 4704, CS 3214, CS 4264).

ECE4806 (3) SENIOR DESIGN PROJECT, Pre: 4805.

## MECHANICAL ENGINEERING SENIOR ENGINEERING DESIGN AND PROJECT

ECE graduating seniors, with the permission of the ME department, can enroll in the ME senior engineering design and project courses. Force-adds must be approved and processed through the ME Advising office. **Note: both semesters must be completed to earn credit.**

ME 4015 (3) Engineering Design and Project [Permission of ME Department]

ME 4016 (3) Engineering Design and Project [Permission of ME Department] **DTE**

## INDEPENDENT STUDIES AND UNDERGRADUATE RESEARCH

The courses listed below can *generally* be used for technical elective credit or design technical elective credit, based on the particular content of each course as it is taught in a given semester. Please discuss technical elective credit options for these courses with your advisor prior to completing the required paperwork to add these courses.

ECE 4974 (ARR) Independent Study

ECE 4994 (ARR) Undergraduate Research

### Notes:

Students must complete the College of Engineering Undergraduate Research/Independent Study Form, the ECE Undergraduate Research/Independent Study Proposal Form, and the ABET Breakdown prior to registration. The forms are due in 340 Whittemore by 2:00 PM on the 3<sup>rd</sup> day of the first week of class for the requested semester – no exceptions. Forms are available online at [www.ece.vt.edu/ugrad/policies.php](http://www.ece.vt.edu/ugrad/policies.php).

For purposes of satisfying the major technical elective requirements, the sum of the number of hours taken from ECE 4974 and 4994 cannot exceed 6 in any one project, without prior approval.

## Non-Major Technical Electives

ECE students may take up to 3 credit hours of non-major technical electives. Students are reminded that they DO NOT have to take a non-major technical elective. *All* technical electives can come from the in-major list.

- 1) Any 3000 or 4000 level course, *except those listed in Items 2 and 3 below*, in Engineering, Engineering non-degree (ENGR), Biology, Biomedical Engineering and Sciences, Chemistry, Computer Science, Mathematics, Nuclear Engineering, Physics, and Statistics **NOT REQUIRED FOR GRADUATION, THAT DOES NOT DUPLICATE** any course in the program of study, and for which you have the appropriate prerequisite, may be used as a non-major technical elective.
- 2) Non-major 4974, 4984, 4994 courses and study abroad courses must be approved for non-major technical elective credit in advance. See your advisor for guidance.
- 3) REMINDER: ESM 4404 – Fundamentals of Professional Engineering – **CANNOT** be used as a non-major technical elective and **DOES NOT COUNT TOWARDS GRADUATION.**

### Graduate Courses Used as Technical Electives

ECE students who meet the University requirements to enroll in graduate courses may use graduate level ECE courses as technical elective credit.

- 1) Per University policy, undergraduate students must have earned a 3.0 cumulative GPA to be eligible to enroll in graduate level courses.
- 2) Note that graduate courses taken as an undergraduate **cannot** be used toward a graduate degree in ECE at VT. Exceptions to this policy: a) students enrolled in the Accelerated UG/G program; b) students who are dual enrolled in the ECE graduate program. Please see your advisor if you have questions regarding this policy.
- 3) To enroll in graduate level courses, undergraduates will need to complete an online ECE force add request. If prerequisites are met and space permits, students will be force-added to the graduate course(s).

**Bradley Department of Electrical and Computer Engineering**  
**Virginia Polytechnic Institute and State University**  
**Engineering and Science Elective List**  
**For Electrical Engineering and Computer Engineering**  
**Graduating in 2020**

EE and CPE majors are required to take one non-major engineering or science course from the following list. Some courses may include prerequisite courses not required for the EE or CpE curriculum. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course.

Enrollment into courses will be based on sufficient resources, including faculty availability and student demand.

Within the College of Engineering:

BSE	3154	Thermodynamics of Biological Systems
CHE	2114	Mass and Energy Balances
ECE	3105	Electromagnetic Fields (CpE majors only)
ESM	2104	Statics
ESM	4084	(AOE 4084) Engineering Design Optimization
ISE	2404	Deterministic Operations Research I
ISE	3414	Probabilistic Operations Research
ME	3134	Fundamentals of Thermodynamics
MSE	2034	Elements of Materials Engineering
MSE	3204	Fundamentals of Electronic Materials
NSEG	3145	Fundamentals of Nuclear Engr

Outside of the College of Engineering:

BIOL	1005	General Biology
BIOL	1006	General Biology
BMVS	4064	(BMES 4064) Introduction to Medical Physiology
CHEM	1036	General Chemistry
PHYS	3324	Modern Physics
PHYS	3355	Intermediate Mechanics
PHYS	3405	Intermediate Electricity and Magnetism (CpE Majors only)
PHYS	3655	Introduction to Astrophysics
PHYS	3656	Introduction to Astrophysics
PHYS	3704	Thermal Physics
PHYS	4574	Nanotechnology
PHYS	4614	Optics
PHYS	4714	Introduction to Biophysics

**Support Letters**

**From:** Clinton Dancy <cld@vt.edu>  
**Subject:** Re: Seeking approval to include ME course in BSEE and BSCPE checksheets  
**Date:** October 25, 2017 at 2:05:35 PM EDT  
**To:** Jaime De La Ree <jreelopez@vt.edu>

Jaime, The ME Department approves of ECE continuing to list these particular courses among the technical electives available to your students on your checksheets.

Clint

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**From:** John Simonetti <jsimonet@vt.edu>  
**Subject:** Re: Seeking approval to include Physics classes on BSEE and BSCPE checksheets  
**Date:** July 31, 2017 at 5:46:57 PM EDT  
**To:** Jaime De La Ree <jreelopez@vt.edu>

Dear Jaime,

Yes, I approve of your new changes.

Thank you,  
John

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**From:** Patricia Amateis <pamateis@vt.edu>  
**Subject:** approval to include chemistry classes on BSEE and BSCPE checksheets  
**Date:** October 25, 2017 at 1:29:21 PM EDT  
**To:** <jreelopez@vt.edu>

Dear Dr. De La Ree,

The Chemistry Department gives approval for listing CHEM 1036 General Chemistry on current EE and CPE checksheets and on the new option checksheets.

Patricia Amateis  
Director of Undergraduate Education  
Chemistry Department

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**From:** Aaron Goldstein <goldst@vt.edu>  
**Subject:** Re: Seeking approval to include CHE course in BSEE and BSCPE checksheets  
**Date:** October 23, 2017 at 4:53:53 PM EDT  
**To:** Jaime De La Ree <jreelope@vt.edu>

Hi Jaime -

You are welcome to continue to list CHE 2114 as a technical elective for ECE and CPE degrees, as well as the new options you are developing.

Your students are welcome to take CHE 2114 based on seat availability after we have accommodated all of our CHE majors.

best wishes,

aaron

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**From:** "Hendricks, Scott" <hndrxsl@vt.edu>  
**Subject:** RE: Seeking approval to include ESM course in BSEE and BSCPE checksheets  
**Date:** October 23, 2017 at 4:14:21 PM EDT  
**To:** "De La Reelopez, Jaime" <jreelope@vt.edu>

Hi Jaime,

The BEAM department is happy to have ECE students continue to include ESM 2104 and ESM 4084 on their checksheets. We will not require any additional resources to teach these students.

Scott Hendricks  
ESM Program Chair

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**From:** Tess Thompson <thwynn@vt.edu>  
**Subject:** Re: Seeking approval to include BSE course in BSEE and BSCPE checksheets  
**Date:** October 23, 2017 at 3:29:38 PM EDT  
**To:** Jaime De La Ree <jreelope@vt.edu>  
**Reply-To:** <tthompson@vt.edu>

Jaime,

The biological systems engineering department approves listing of BSE 3154 on the checksheets for the new majors in the ECE department.

Best regards,

Tess

**Dr. Tess Thompson**

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**From:** Stephen H Edwards <edwards@cs.vt.edu>  
**Subject:** Re: CS Courses in ECE Checksheets  
**Date:** October 23, 2017 at 9:14:36 AM EDT  
**To:** Jaime De La Ree <jreelope@vt.edu>

The Department of Computer Science approves the inclusion of CS 3214 in the Software Systems major checksheet.

-- Steve

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Virginia Tech, CS Dept.    Web-CAT: Web-based Center for Software Testing  
2202 Kraft Drive        Automatic grading using student-written tests  
Blacksburg, VA 24060 USA    <http://web-cat.org/>  
(540)-231-5723        <http://people.cs.vt.edu/~edwards/>

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**From:** Richard Walker <rawalker@vt.edu>  
**Subject:** Re: Seeking approval to include Biology classes on BSEE and BSCPE checksheets  
**Date:** October 20, 2017 at 8:56:56 AM EDT  
**To:** Jaime De La Ree <jreelope@vt.edu>

Yes, that is fine.

Rich

On Fri, Oct 20, 2017 at 8:54 AM, Jaime De La Ree <jreelope@vt.edu> wrote:  
Richard:

Thanks for the support from the Biological Science Department.

As the new course, BIOL 1014 is not yet approved, I would like to leave BIOL 1005 and BIOL1006 in my checksheet knowing that as you decide to phase-out these two courses and the new one is fully approved we will have to make a blanket substitution for our students in the graduating class of 2020.

I hope this is OK with your department.

Thanks for the support.

Best

Jaime

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**From:** John Shewchuk <shewchuk@vt.edu>  
**Subject:** Re: ISE Courses in ECE Checksheets  
**Date:** October 20, 2017 at 8:18:23 AM EDT  
**To:** Jaime De La Ree <jreelopez@vt.edu>

Jaime,

The ISE Department approves ECE's continued listing of ISE 2014 and ISE 2404 on current EE and CPE checksheets, as well as on new option checksheets, given that EE/CPE student enrollment in these courses continues as normally expected through student population growth. No EE/CPE-restricted sections of either course are anticipated at this time.

Regards,

John Shewchuk

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**From:** "Fricker, Ronald" <fricker@vt.edu>  
**Subject:** Re: Seeking approval to include Statistics classes on BSEE and BSCPE checksheets  
**Date:** July 20, 2017 at 4:56:49 PM EDT  
**To:** "De La Reelopez, Jaime" <jreelopez@vt.edu>

Hi Jaime,

The Department of Statistics is in complete agreement with continuing to list STAT 4714 on the new BSEE and BSCPE checksheets.

I don't know if you list any other statistics courses as electives. If not, the department would also welcome including such electives and I'd be happy to discuss that with you if it's of interest.

Best regards,  
Ron

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**From:** Peter Haskell <phaskell@math.vt.edu>  
**Subject:** Re: Seeking approval to include MATH classes on BSEE and BSCPE checksheets  
**Date:** July 20, 2017 at 11:44:58 AM EDT  
**To:** Jaime De La Ree <jreelopez@vt.edu>  
**Cc:** Lizette Zietsman <lzietsma@gmail.com>

Dear Jaime,

Thank you for writing to explain your plans to create additional options within your BSEE and BSCPE degrees. As you note, your degrees require many math courses and require one math technical elective from a menu of choices. The changes you propose will formally recognize students' decisions to specialize within your existing degrees, but they will not, in themselves, change the number of students pursuing your degrees or the math courses taken by your students. For these reasons the changes will not affect math enrollments, and so the Math Department will be able to accommodate your changes without requiring any additional resources. You may list on all new and continuing checksheets all the math courses currently appearing on your checksheets.

Peter

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**From:** Bernice Hausman <bhausman@vt.edu>  
**Subject:** Re: Seeking approval to include English classes on BSEE and BSCPE checksheets  
**Date:** July 20, 2017 at 11:11:30 AM EDT  
**To:** Jaime De La Ree <jreelopez@vt.edu>  
**Cc:** Jennifer Mooney <jenmoon@vt.edu>

Dear Jaime:

As you know from my meeting with associate department heads in Engineering on July 10, the Department of English is committed to offering English 1105 and 1106 to all Virginia Tech undergraduates who require these courses to graduate. We are happy to have you include these courses on your majors' checksheets.

The situation with ENGL 3764 is different. The English department is not confident of its ability to meet existing and future demand for ENGL 3764, Technical Writing. This is not merely a resource issue, but a question of how the department will accommodate growth in the university's undergraduate student body in relation to its existing and future commitments to the teaching of writing in the freshman year. I cannot promise that the students in your programs will be able to find a seat in ENGL 3764 in future semesters, as we are likely to have to decrease the number of sections offered in order to meet growing demand in first-year writing.

I want you to know this as it will help your department plan for the future of your programs. The English department has a variety of courses at all levels that will meet Pathways outcomes in Discourse, thereby allowing students to meet that requirement for general education. In addition, we plan to continue to offer ENGL 3764 during the regular academic year and also during winter and summer sessions, although the regular semester offerings will be pared somewhat to accommodate growth in first-year writing. Because your majors already include ENGL 3764 on the checksheets, I cannot tell you to remove it. However, I do feel an obligation to let you know what our situation appears to be right now. Perhaps with more clarification of the PIBB model, this situation will change.

Sincerely,

BH  
Bernice L. Hausman



**From:** Ahmed, S [ansrahmd@vt.edu](mailto:ansrahmd@vt.edu)>  
**Subject:** Re: Seeking approval to include BMVS classes on BSEE and BSCPE checksheets  
**Date:** October 23, 2017 at 10:33 AM EDT  
**To:** Jaime De La Ree <[jreelope@vt.edu](mailto:jreelope@vt.edu)>

Hello Jamie,

Sorry we did not circle back.

Sure- I approve. My best.

*Dr. Ansar Ahmed*

*Associate Dean Research and Graduate Studies*

*Professor of Immunology*

*Director, NIH and Boehringer-Ingelheim DVM Summer Research Training Programs*

*Head, Biomedical and Veterinary Sciences Graduate Program*

*Professor, Virginia Tech Faculty of Health Sciences*

*Virginia-Maryland Regional College of Veterinary Medicine*

*Virginia Tech, Blacksburg, VA 24061*

*Tel: 540-231-4652 (Main office); Fax: 540-231-6033 (fax)*

*e-mail: [ansrahmd@vt.edu](mailto:ansrahmd@vt.edu)*



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**From:** Sean Corcoran <[sgc@vt.edu](mailto:sgc@vt.edu)>  
**Subject:** Re: Seeking approval to include MSE course in BSEE and BSCPE checksheets  
**Date:** October 23, 2017 at 10:04:42 PM EDT  
**To:** Jaime De La Ree <[jreelope@vt.edu](mailto:jreelope@vt.edu)>

MSE approves the listing of 2034 and 3204 as technical electives in your new degree checksheets.