



VirginiaTech

College of Engineering

The Bradley Department of Electrical and
Computer Engineering

302 Whittemore Hall (0111)
Blacksburg, Virginia 24061
540/231-7494 Fax: 540/231-3362

October 23rd, 2017

To: University Registrar

From: Jaime De La Ree, ECE Assistant Department Head

Re: EE Degree, Photonics 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 Electrical Engineering – Major in Photonics.

This is a new checksheet for this Major based on the Electrical 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 31st, 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 ELECTRICAL ENGINEERING
PHOTONICS MAJOR
FOR STUDENTS GRADUATING IN CALENDAR YEAR 2020
132 CREDITS REQUIRED FOR GRADUATION

| FALL SEMESTER FRESHMAN 2016 | | Credits | SPRING SEMESTER FRESHMAN 2017 | | Credits |
|--|-----------------------|---------|---|-----------------------|---------|
| CHEM 1035 General Chemistry <i>Co: MATH 1025 or 1225</i> | 3 | | ENGL 1106 First-Year Writing <i>Pre: ENGL 1105</i> | 3 | |
| CHEM 1045 General Chemistry Lab <i>Co: CHEM 1035</i> | 1 | | MATH 1226 Calculus of a Single Variable <i>Pre: MATH 1225</i> | 4 | |
| ENGL 1105 First-Year Writing | 3 | | PHYS 2305 Foundations of Physics I <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</i> | 4 | |
| MATH 1225 Calculus of a Single Variable (C-) <i>Pre: Math Ready</i> | 4 | | ENGE 1216 Foundations of Engineering (C-) <i>Pre: ENGE 1215</i> | 2 | |
| ENGE 1215 Foundations of Engineering (C-) <i>Co: MATH 1225</i> | 2 | | ECE 1574 ⁽¹⁾ Engineering Problem Solving w/C++ (C-) <i>Pre: ENGE 1024 or ENGE 1215, (MATH 1205 or MATH 1205H or MATH 1225)</i> | 3 ^[F,S] | |
| CLE (Area 2, 3, or 7) | 3 | | MATH 1114 Elementary Linear Algebra OR MATH 2114 Introduction to Linear Algebra <i>Pre: MATH 1226 or a grade of at least B in MATH 1225</i> | 2-3 | |
| TOTAL | 16 | | TOTAL | 18-19 | |
| FALL SEMESTER SOPHOMORE 2017 | | Credits | SPRING SEMESTER SOPHOMORE 2018 | | Credits |
| MATH 2214 Introduction to Differential Equations (C-) <i>Pre: 1114 or 1114H or 2114 or 2114H, (1206 or 1226)</i> | 3 | | MATH 2204 Introduction to Multivariable Calculus (C-) <i>Pre: MATH 1226</i> | 3 | |
| PHYS 2306 Foundations of Physics I (C-) <i>Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305</i> | 4 | | ECE 2204 ⁽¹⁾ Electronics (C-) <i>Pre: 2004</i> | 3 ^[F,S,SI] | |
| ECE 2004 ⁽¹⁾ Electric Circuit Analysis (C-) <i>Pre: ENGE 1216; Co: MATH 2214</i> | 3 ^[F,S,SI] | | ECE 2274 ⁽¹⁾ Electronic Networks Laboratory I (C-) <i>Pre: 2074; Co: 2204</i> | 1 ^[F,S,SI] | |
| ECE 2014 ⁽¹⁾ Engineering Professionalism in ECE (C-) <i>Pre: Sophomore standing, Co: 2004 or 2504</i> | 2 ^[F,S] | | ECE 2534 ⁽¹⁾ Microcontroller Programming and Interfacing <i>Pre: 2504</i> | 4 ^[F,S] | |
| ECE 2074 ⁽¹⁾ Electric Circuit Analysis Laboratory (C-) <i>Pre: ENGE 1104 or ENGE 1204 or ENGE 1216. Co: 2004, MATH 2214</i> | 1 ^[F,S,SI] | | ECE 2704 ⁽¹⁾ Signals and Systems (C-) <i>Pre: (2004 or 2004H), 2074, (MATH 2214 or MATH 2214H)</i> | 3 ^[F,S,SI] | |
| ECE 2504 ⁽¹⁾ Introduction to Computer Engineering (C-) <i>Pre: 1574</i> | 3 ^[F,S,SI] | | CLE (Areas 2, 3, or 7) | 3 | |
| TOTAL | 16 | | TOTAL | 17 | |
| FALL SEMESTER JUNIOR 2018 | | Credits | SPRING SEMESTER JUNIOR 2019 | | Credits |
| ECE 3004 ⁽²⁾ AC Circuit Analysis (C-) <i>Pre: 2704</i> | 3 ^[F,S] | | ECE 3106 ⁽²⁾ Electromagnetic Fields (C-) <i>Pre: 3105</i> | 3 ^[F,S,SI] | |
| STAT 4714 Probability & Statistics for EE (C-) <i>Pre: (MATH 2204 or MATH 2224)</i> | 3 | | Photonics Technical Elective from list | 3 | |
| ENGL 3764 Technical Writing <i>Pre: Junior standing</i> | 3 | | Free Elective | 2-3 | |
| ECE 3074 ⁽²⁾ AC Circuit Analysis Laboratory (C-) <i>Pre: 2074; Co: 3004</i> | 1 ^[F,S] | | ECE 3134 ⁽²⁾ Introduction to Optoelectronics <i>Pre: 3105</i> | 3 ^[S] | |
| ECE 3105 ⁽²⁾ Electromagnetic Fields (C-) <i>Pre: PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224 or MATH 2224H), (ECE 2004 or ECE 2004H)</i> | 3 ^[F,S,SI] | | ECE 3174 ⁽²⁾ Optoelectronics Laboratory <i>Pre: 2274; Co: 3134</i> | 1 ^[S] | |
| MATH Elective from list | 3 ^[F,S,SI] | | ECE 3614 ⁽²⁾ Introduction to Communication Systems (C-) <i>Pre: 2704, STAT 4714</i> | 3 ^[F,S,SI] | |
| TOTAL | 16 | | CLE (Area 6) | 1 | |
| TOTAL | 16 | | TOTAL | 16-17 | |
| FALL SEMESTER SENIOR 2019 | | Credits | SPRING SEMESTER SENIOR 2020 | | Credits |
| ISE 2014 Engineering Economy <i>Pre: ENGE 1024 or ENGE 1215 or BC 1224</i> | 2 | | ECE 4806 ⁽¹⁾ Senior Design Project <i>Pre: 4805</i> | 3 ^[F,S] | |
| ECE 4134 ⁽²⁾ Photonics <i>Pre: 3106</i> | 3 ^[F] | | ECE 4144 ⁽²⁾ Optical Systems <i>Pre: 3106</i> | 3 ^[S] | |
| Engineering and Science Elective from list | 3 | | Photonics Technical Elective from list | 3 | |
| ECE 4805 ⁽¹⁾ Senior Design Project (C-) <i>See timetable for prereqs</i> | 3 ^[F,S] | | CLE (Areas 2, 3, or 7) | 3 | |
| Photonics Technical Elective from list | 3 | | CLE (Areas 2, 3, or 7) | 3 | |
| CLE (Areas 2, 3, or 7) | 3 | | | | |

| | | | | | | | |
|--|--|--------------|-----------|--|--|--------------|-----------|
| | | TOTAL | 17 | | | TOTAL | 15 |
|--|--|--------------|-----------|--|--|--------------|-----------|

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

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 132 credits.

Electives

The Electrical Engineering degree with a major in Photonics requires 9 credits of Photonics technical electives from list, 3 hours of engineering and science electives from list, 3 hours of math electives from list, and 2 or 3 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 Electrical 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 60 credits, EE students must have satisfactorily completed ECE 2014, ECE 2004, MATH 2214 and 2204, and PHYS 2306
- Upon attempting 90 credits, EE students must have successfully completed 33 credits of in-major courses (including ECE 2534) and have 2.0 overall and in-major GPAs. (In determining the EE 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. Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current requirements.

Graduation Requirements: Each student must complete at least 132 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00.

**TECHNICAL ELECTIVES FOR
ELECTRICAL ENGINEERING UNDERGRADUATES
Photonics
Graduating 2020**

The courses listed below are approved for EE 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.

ELECTROMAGNETICS

- ECE3104 (3) INTRODUCTION TO SPACE SYSTEMS AND TECHNOLOGIES, Pre: 2204, 3105.
- ECE3154 (1) SPACE SYSTEMS LAB, Pre: 3105. Co: 3104.
- ECE4104 (4) MICROWAVE AND RF ENGINEERING, Pre: 3106, 3204, 2014.
- ECE4114 (3) ANTENNAS, Pre: 3106, 2014.
- ECE4124 (3) RADIO WAVE PROPAGATION, 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

- 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.

ECE3714 (3) INTRODUCCION TO CONTROL SYSTEM, 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.)

COMPUTERS

ECE2500 (3) COMPUTER ORGANIZATION AND ARCHITECTURE, Pre: 2504.

ECE2574 (3) DATA STRUCTURES AND ALGORITHMS, Pre: 1574.

ECE3544 (4) DIGITAL DESIGN I, Pre: 2504, C- or better, Pre: 2204 or MSE 3204.

ECE3574 (3) APPLIED SOFTWARE DESIGN, Pre: 2574.

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).

ECE4524 (4) ARTIFICIAL INTELLIGENCE AND ENGINEERING APPLICATIONS, Pre: 2574, STAT 4714. **DTE**

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.

COMMUNICATIONS

ECE3604 (3) INTRODUCTION TO RF & MICROWAVE ENGINEERING, Pre: 2004, 3105.

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.

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. **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]

INDEPENDENT STUDY 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 registering for the 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 3rd 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.

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
Math Elective List for Electrical Engineering
Graduating in 2020**

Electrical Engineering majors are required to take one math elective course from the following list. There are no hidden prerequisites for these courses for EE majors: prerequisite courses, if any, are also required courses within the EE curriculum.

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

- MATH 3034 (3) INTRODUCTION TO PROOFS, (limited availability due to course restrictions), Pre: MATH 2114 or MATH 2114H or MATH 2405H.
- MATH 3214 (3) CALCULUS OF SEVERAL VARIABLES , Pre: MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005.
- MATH 3414 (3) NUMERICAL METHODS (CS 3414), Pre: (CS 1044 or CS 1705 or CS 1114 or CS 1124), MATH 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H).
- MATH 4445 (3) INTRODUCTION TO NUMERICAL ANALYSIS, Pre: MATH 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H) or (MATH 2204 or MATH 2204H).
- MATH 4446 (3) INTRODUCTION TO NUMERICAL ANALYSIS, Pre: MATH 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H).
- MATH 4564 (3) OPERATIONAL METHODS FOR ENGINEERS, Pre: (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006.
- MATH 4574 (3) VECTOR AND COMPLEX ANALYSIS FOR ENGINEERS, Pre: MATH 2224 or MATH 2204 or MATH 2204H]

Bradley Department of Electrical and Computer Engineering
Virginia Polytechnic Institute and State University
Engineering and Science Elective List
For Electrical Engineering and Computer Engineering majors
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

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

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

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 <jreelopez@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

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" <jreelopez@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

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 <jreelopez@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

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

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/>

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

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

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

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

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>
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>

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



From: Sean Corcoran <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>

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