<table>
<thead>
<tr>
<th>FALL SEMESTER FRESHMAN 2016</th>
<th>Credits</th>
<th>SPRING SEMESTER FRESHMAN 2017</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>CHEM 1035 General Chemistry Co: MATH 1025 or 1225</td>
<td>3</td>
<td>ENGL 1106 First-Year Writing Pre: ENGL 1105</td>
<td>3</td>
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<tr>
<td>CHEM 1045 General Chemistry Lab Co: CHEM 1035</td>
<td>1</td>
<td>MATH 1226 Calculus of a Single Variable Pre: MATH 1225</td>
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<tr>
<td>ENGL 1105 First-Year Writing</td>
<td>3</td>
<td>PHYS 2305 Foundations of Physics I Co: PHYS 2205 or MATH 1206 or MATH 120H or MATH 1226. Pre: MATH 1205 or MATH 1205H or MATH 1226 or MATH 1206 or MATH 1206H or MATH 1226H or MATH 1226H</td>
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<tr>
<td>MATH 1225 Calculus of a Single Variable (C-) Pre: Math Ready</td>
<td>4</td>
<td>ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215</td>
<td>2</td>
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<tr>
<td>ENGE 1215 Foundations of Engineering (C-) Co: MATH 1225</td>
<td>2</td>
<td>ECE 1574[1] Engineering Problem Solving w/C++ (C-) Pre: ENGE 1024 or ENGE 1215, (MATH 1205 or MATH 1205H or MATH 1225)</td>
<td>3</td>
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<tr>
<td>CLE (Area 2, 3, or 7)</td>
<td>3</td>
<td>MATH 1114 Elementary Linear Algebra OR MATH 2114 Introduction to Linear Algebra Pre: MATH 1226 or a grade of at least B in MATH 1225</td>
<td>2-3</td>
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<tr>
<th>FALL SEMESTER SOPHOMORE 2017</th>
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<tr>
<td>MATH 2214 Introduction to Differential Equations (C-) Pre: 1114 or 1114H or 2114 or 2114H, (1206 or 1226)</td>
<td>3</td>
<td>MATH 2204 Introduction to Multivariable Calculus (C-) Pre: MATH 1226</td>
<td>3</td>
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<tr>
<td>PHYS 2305 Foundations of Physics I (C-) Pre: MATH 1206 or MATH 1206H or MATH 1226, PHYS 2305</td>
<td>4</td>
<td>ECE 2204[1] Electronics (C-) Pre: 2004</td>
<td>3[3,5,5]</td>
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<tr>
<td>ECE 2504[1][2] Introduction to Computer Engineering (C-) Pre: 1574</td>
<td>3[3,5,5]</td>
<td>CLE (Areas 2, 3, or 7)</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>TOTAL</strong></td>
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<th>FALL SEMESTER JUNIOR 2018</th>
<th>Credits</th>
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<tr>
<td>STAT 4714 Probability &amp; Statistics for Electrical Engineers (C-) Pre: MATH 2204 or MATH 2224</td>
<td>3</td>
<td>ECE 3614[1] Introduction to Communication Systems (C-) Pre: 2704, STAT 4714</td>
<td>3[3,5,5]</td>
</tr>
<tr>
<td>ECE 3105[1][2] Electromagnetic Fields (C-) Pre: PHYS 2306, (MATH 2204 or MATH 2204H or MATH 2224 or MATH 2224H), (ECE 2004 or ECE 2004H)</td>
<td>3[3,5,5]</td>
<td>Communications &amp; Networking Technical Elective from list</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 3764 Technical Writing Pre: Junior standing</td>
<td>3</td>
<td>CLE (Areas 2, 3, or 7)</td>
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<tr>
<td>ECE 3704[1] (C-) Continuous &amp; Discrete System Theory Pre: 2704</td>
<td>3[3,5,5]</td>
<td>CLE (Areas 2, 3, or 7)</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
<td><strong>TOTAL</strong></td>
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<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>ISE 2014 Engineering Economy Pre: ENGE 1024 or ENGE 1215 or BC 1224</td>
<td>2</td>
<td>ECE 4806[1] Senior Design Project Pre: 4805</td>
<td>3[3,5]</td>
</tr>
</tbody>
</table>
**General Information about Checksheets**: 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 Alphabetic Listing at: [http://www.cle.prov.vt.edu/guides/alpha.html](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 Communications & Networking requires 9 Credits of Communications & Networking Tech Electives from list, 3 hours of engineering and science electives from list, 3 hours of math electives from list, and 2-3 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](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
Communications & Networking
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.
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

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.

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### 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
- **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 (ECE3254, 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.

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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.
ECE4634 (3) DIGITAL COMMUNICATIONS, Pre: 3614, STAT 4714.
ECE4664 (1) ANALOG & DIGITAL COMMUNICATIONS LABORATORY, Pre: 3614. Co: 4634
ECE4675 (1) RADIO ENGINEERING LABORATORY, Pre: 3105, 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 Whittlemore 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.

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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).
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]
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   |
| NSSEG| 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            |