College Of Engineering
Bradley Department of Electrical and Computer Engineering

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Bachelor of Science in Electrical Engineering

For Students Graduating in Calendar Year 2021

132 Credits Required for Graduation

Fall Semester Freshman 2017	Credits
CHEM 1035 General Chemistry	3
CHEM 1045 General Chemistry Lab *Co: CHEM 1035*	1
ENGL 1105 First-Year Writing	3
MATH 1225 Calculus of a Single Variable **(C-)** *Pre: Math Ready*	4
ENGE 1215 Foundations of Engineering **(C-)**	2
CLE (Area 2, 3, or 7)	3
TOTAL	**16**

Spring Semester Freshman 2018	Credits
ENGL 1106 First-Year Writing *Pre: ENGL 1105*	3
MATH 1226 Calculus of a Single Variable *Pre: MATH 1225*	4
PHYS 2305 Foundations of Physics I *Co: MATH 1226 Pre: MATH 1225 or MATH 1226*	4
ENGE 1216 Foundations of Engineering **(C-)** *Pre: ENGE 1215*	2
ECE 1574[1] Engineering Problem Solving w/C++ **(C-)** *Pre: (ENGE 1215 or ENGE 1414), MATH 1225*	3[F,S,SI]
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*	2-3
TOTAL	**18-19**

Fall Semester Sophomore 2018	Credits
MATH 2214 Introduction to Differential Equations **(C-)** *Pre: 1114 or 1114H or 2114 or 2114H), 1226*	3
PHYS 2306 Foundations of Physics I **(C-)** *Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305*	4
ECE 2004[1] Electric Circuit Analysis **(C-)** *Pre: ENGE 1216 or ENGE 1414; Co: MATH 2214*	3[F,S,SI]
ECE 2014[1] Engineering Professionalism in ECE **(C-)** *Pre: Sophomore standing, Co: 2004 or 2504*	2[F,S]
ECE 2074[1] Electric Circuit Analysis Laboratory **(C-)** *Pre: ENGE 1216 or ENGE 1414 Co: 2004, MATH 2214*	1[F,S,SI]
ECE 2504[1] Introduction to Computer Engineering **(C-)** *Pre: 1574*	3[F,S,SI]
TOTAL	**16**

Spring Semester Sophomore 2019	Credits
MATH 2204 Introduction to Multivariable Calculus **(C-)** *Pre: MATH 1226*	3
ECE 2204[1] Electronics **(C-)** *Pre: 2004*	3[F,S,SII]
ECE 2274[1] Electronic Networks Laboratory I **(C-)** *Pre: 2074; Co: 2204*	1[F,S,SII]
ECE 2534[1] Microcontroller Programming and Interfacing **(C-)** *Pre: 2504*	4[F,S]
ECE 2704[1] Signals and Systems **(C-)** *Pre: (2004 or 2004H), 2074, (MATH 2214 or MATH 2214H)*	3[F,S,SII]
CLE (Areas 2, 3, or 7)	3
TOTAL	**17**

Fall Semester Junior 2019	Credits
ECE 3004 AC Circuit Analysis **(C-)** *Pre: 2704*	3[F,S]
STAT 4714 Probability & Statistics for Electrical Engineers **(C-)** *Pre: MATH 2204*	3
ENGL 3764 Technical Writing *Pre: Junior standing*	3
ECE 3074 AC Circuit Analysis Laboratory **(C-)** *Pre: 2074; Co: 3004*	1[F,S]
ECE 3105 Electromagnetic Fields **(C-)** *Pre: PHYS 2306, MATH 2204, ECE 2004*	3[F,S,SI]
ECE 3704 Continuous & Discrete System Theory *Pre: 2704*	3[F,S,SII]
TOTAL	**16**

Spring Semester Junior 2020	Credits
ECE 3106 Electromagnetic Fields *Pre: 3105*	3[F,S,SII]
ECE 3204 Analog Electronics *Pre: 2204, 2704 Co: 3274*	3[F,S]
ECE 3274 Electronic Circuits Laboratory II *Pre: 2274, 3074 Co: 3204*	1[F,S]
ECE 3304 Introduction to Power Systems *Pre: 3004*	3[F,S]
ECE 3354 Electric Power Engineering Laboratory *Co: 3304*	1[F,S]
ECE 3614 Introduction to Communication Systems *Pre: 2704, STAT 4714*	3[F,S,SI]
CLE (Area 6)	1
TOTAL	**15**

Fall Semester Senior 2020	Credits
ISE 2014 Engineering Economy *Pre: ENGE 1215 or ENGE 1414 or BC 1224*	2
MATH Elective from list	3
Engineering and Science Elective from list	3
ECE 4805[1] Senior Design Project **(C-)** *See timetable for prereqs*	3[F,S]
EE Tech Elective from List	3
CLE (Areas 2, 3, or 7)	3
TOTAL	**17**

Spring Semester Senior 2021	Credits
ECE 4806[1] Senior Design Project *Pre: 4805*	3[F,S]
EE Tech Elective from list	3
EE Tech Elective from list	3
CLE (Areas 2, 3, or 7)	3
CLE (Areas 2, 3, or 7)	3
Free Elective	1-2
TOTAL	**16-17**

General Information about Checksheet: Superscripted annotation after the course number (1) indicates core course of the degree. Additionally, (F,S,SI,SII) in credits column indication 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 EE degree requires 9 credits of technical electives from list, 3 hours of engineering and science electives from list, 3 hours of math 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 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 Prerequisites: Pre-requisites for each course are listed after the course title. All ECE courses require a C- or better in prerequisite courses. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes 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. In determining the EE in-major GPA, all ECE courses, including repeats, are used.

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TECHNICAL ELECTIVES FOR
ELECTRICAL ENGINEERING UNDERGRADUATES
Electrical Engineering
Graduating 2021

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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. All ECE courses require a **C- or better** in prerequisite courses. **Technical electives cannot be double counted with required courses.**

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) or 3054.

ECE3134 (3) INTRODUCTION TO OPTOELECTRONICS, Pre: 2204.

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.

ECE4114 (3) ANTENNAS, Pre: 3106.

ECE4124 (3) RADIO WAVE PROPAGATION, Pre: 3106.

ECE4134 (3) PHOTONICS, Pre: 3106.

ECE4144 (3) OPTICAL SYSTEMS, Pre: 3105.

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

ECE3214 (3) SEMICONDUCTOR DEVICE FUNDAMENTALS, Pre: 2204 or MSE 3204

ECE4205 (3) ELECTRONIC CIRCUIT DESIGN, Pre: 3204.

ECE4206 (3) ELECTRONIC CIRCUIT DESIGN, Pre: 4205.

ECE4220 (3) ANALOG INTEGRATED CIRCUIT DESIGN, Pre: 3204.

ECE4224 (3) POWER ELECTRONICS, Pre: 3204.

ECE4234 (3) SEMICONDUCTOR PROCESSING, Pre: 2204 or 3054.

ECE4244 (3) INTERMEDIATE SEMICONDUCTOR PROCESSING LABORATORY, Pre: 4234 or MSE 4234.

ECE4284 (1) POWER ELECTRONICS LABORATORY, Co: 4224.

POWER SYSTEMS

ECE4304 (3) DESIGN IN POWER ENGINEERING, Pre: 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) INTRODUCTION TO CONTROL SYSTEM, Pre: 2704.

ECE4704 (3) PRINCIPLES OF ROBOTICS SYSTEMS, Pre: 2704 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.

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: 2500 or CS 3214.

ECE4514 (4) DIGITAL DESIGN II, Pre: 3544.

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.

ECE4525 (3) VIDEO GAME DESIGN AND ENG, Pre: 3574.

ECE4526 (3) VIDEO GAME DESIGN AND ENG, Pre: 4525.

ECE4530 (3) HARDWARE-SOFTWARE CODESIGN, Pre: 2534, (3504 or 3544).

ECE4534 (4) EMBEDDED SYSTEM DESIGN, Pre: 2014, 2534, 3574.

ECE4540 (3) VLSI CIRCUIT DESIGN, Pre: 2204, 2504.

ECE4550 (3) REAL-TIME SYSTEMS, Pre: 3574 or CS 3214.

ECE4554 (3) INTRODUCTION TO COMPUTER VISION, Pre: 3574, (STAT 4705 or STAT 4714).

ECE4560 (3) COMPUTER AND NETWORK SECURITY FUNDAMENTALS, Pre: 2504 or CS 3214.

ECE4564 (3) NETWORK APPLICATION DESIGN, Pre: 2504, 2574.

ECE4570 (3) WIRELESS NETWORKS AND MOBILE SYSTEMS (CS 4570), Pre: 4564.

ECE4574 (3) LARGE-SCALE SOFTWARE DEVELOPMENT FOR ENGINEERING SYSTEMS, Pre: 3574.

ECE4580 (3) DIGITAL IMAGE PROCESSING.

COMMUNICATIONS

ECE3604 (3) INTRODUCTION TO RF & MICROWAVE ENGINEERING, Pre: 2204, 3105.

ECE4605 (3) RADIO ENGINEERING, Pre: 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: 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: 3105. 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.

4974 (ARR) Independent Study
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 12:00 noon 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/undergrad/policies.

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).

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Bradley Department of Electrical and Computer Engineering
Virginia Polytechnic Institute and State University
Math Elective List for Electrical Engineering
Graduating in 2021

Electrical Engineering majors are required to take one math elective course from the following list. Some courses may include prerequisite courses not required for the EE 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.

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 2021

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
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
BIOL	1014	Introduction to 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