College Of Engineering
Bradley Department of Electrical and Computer Engineering
Degree: Bachelor of Science in Computer Engineering
Major: Machine Learning
For students entering under UG Catalog 2022-2023
Credits Required for graduation: 131

FALL SEMESTER FIRST YEAR	Credits	SPRING SEMESTER FIRST YEAR	Credits
CHEM 1035 General Chemistry Co: Eligible to enroll	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 Pre: MATH 1225 or MATH 1226; Co: MATH 1226	4
MATH 1225 Calculus of a Single Variable (C-) Pre: Eligible to enroll	4	ENGE 1216 Foundations of Engineering (C-) Pre: ENGE 1215	2
ENGE 1215 Foundations of Engineering (C-)	2	ECE 1004[1] Introduction to ECE Concepts (C) Pre: ENGE 1215 or ENGE 1414	3[F, S]
Pathways 2 or 3 or 6a	3	MATH 2114 Introduction to Linear Algebra (C-) Pre: MATH 1226 or a grade of at least B in MATH 1225	3
TOTAL	**16**	**TOTAL**	**19**

FALL SEMESTER SECOND YEAR	Credits	SPRING SEMESTER SECOND YEAR	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 Pre: (MATH 1206 or MATH 1206H or MATH 1226), PHYS 2305	4	ECE 2214[2] Physical Electronics (C) Pre: 2024	3[F, S]
ECE 2024[1] Circuits and Devices (C) Pre: 1004, (MATH 2114 or MATH 2114H or MATH 2405H) ; Co: 2514, 2544, MATH 2214, PHYS 2306	3[F, S]	ECE 2564[1] Embedded Systems (C) Pre: 2514, 2544	3[F, S]
ECE 2514[1] Computational Engineering (C) Pre: 1004; Co: 2024, 2544	3[F, S]	ECE 2714[2] Signals and Systems(C) Pre: 2024, 2514, 2544. MATH 2214; Co: 2564	3[F, S]
ECE 2544[1] Fundamentals of Digital Systems (C) Pre: 1004; Co: 2024, 2514	3[F, S]	ECE 2804[1] Integrated Design Project (C) Pre: 2024, 2514, 2544; Co: 2214, 2564, 2714	2[F, S]
		Pathways 2 or 3 or 6a	3
TOTAL	**16**	**TOTAL**	**17**

FALL SEMESTER THIRD YEAR	Credits	SPRING SEMESTER THIRD YEAR	Credits
ECE 3504[2] Computer Organization and Architecture (C-) Pre: 2804	3[F,S]	ECE 3574[1] Applied Software Design (C-) Pre: 2804, (2574 or 3514)	3[F,S]
ECE 3514[1] Data Structure and Algorithms (C-) Pre: 2804	3[F, S]	MATH 2534 Introduction to Discrete Math Pre: CS 1114 or ECE 1574 or ECE 1004	3
STAT 4714 Probability and Statistics for Electrical Engineers (C-) Pre: MATH 2204 or MATH 2204H	3	ECE 4524[2] Artificial Intelligence and Engineering Applications Pre: (2574 or 3514), STAT 4714	4[S]
Secondary Focus Area course (see list)	3	Secondary Focus Area course (see list)	3
Free Elective	3	Pathways 2 or 3 or 6a	3
Free Elective	2		
TOTAL	**17**	**TOTAL**	**16**

FALL SEMESTER FOURTH YEAR	Credits	SPRING SEMESTER FOURTH YEAR	Credits
ECE 4805 Senior Design Project (C-) Pre: ECE 2804, (ECE 3004 or ECE 3504), (ECE 3105 or ECE 3514), (one course from list**)	3[F,S]	ECE 4806 Senior Design Project Pre: 4805	3[F,S]
ECE 4525[2] Video Game Design and Engineering Pre: 3574 or ECE 4580 Digital Image Processing Pre: 2714, 2804	3[F]	Secondary Focus Area course (see list)	3
ECE 4424[2] Machine Learning Pre: (2574 or 3514), (STAT 4714 or STAT 4704 or STAT 4705)	3[F,S]	Pathways 2 or 3 or 6a	3
ECE 4554[2] Introduction to Computer Vision Pre: 3574, (STAT 4714 or STAT 4704 or STAT 4705)	3[F]	Pathways 7 or Free Elective (if Pathways 7 double counted)	3
Pathways 2 or 3 or 6a	3	Free Elective	3
TOTAL	**15**		**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 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.

**Must take one of the following courses to complete the prerequisites for ECE 4805: ECE 3106 or ECE 3134 or ECE 3204 or ECE 3304 or ECE 3544 or ECE 3564 or ECE 3574 or ECE 3614 or ECE 3704 or ECE 4205 or ECE 4234 or ECE 4254 or ECE 4424 or ECE 4540 or ECE 4524 or ECE 4580 or ECE 4704

Pathways to General Education (Pathways)
Consult the pathways courses table: https://www.pathways.prov.vt.edu/about/table.html. Pathways courses need to be completed prior to graduation

Pathways Concept 1: Discourse (6 hrs foundational, 3 hrs advanced)	*Foundational:* **ENGL 1105**	(3)	*Foundational:* **ENGL 1106**	(3)
	Advanced: **ECE 4805 + ECE 4806**			(6)
Pathways Concept 2: Critical Thinking in the Humanities (6 hrs)		(3)		(3)
Pathways Concept 3: Reasoning in the Social Sciences (6 hrs)		(3)		(3)
Pathways Concept 4: Reasoning in the Natural Sciences (8 hrs)	**CHEM 1035 + CHEM 1045**	(4)	**PHYS 2305**	(4)
Pathways Concept 5: Quantitative and Computational Thinking (11 hrs)	*Foundational:* **MATH 1225**	(4)	*Foundational:* **MATH 1226**	(4)
	Advanced: **MATH 2214**			(3)
Pathways Concept 6: Critique and Practice in Design and the Arts (7 hrs)	*Arts (6a):*			(3)
	Design: **ENGE 1215 + ENGE 1216**			(4)
Pathways Concept 7: Critical Analysis of Identity & Equity in the US (3 hrs)	*Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.			(3)

Electives

The Machine Learning Major requires 8 hours of free electives. Only free electives may be taken under the P/F grading option. Students are encouraged to use free elective credits to provide depth in their major or secondary focus.

Secondary Focus

The Machine Learning Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below (page 3) for more information.

Change of Major Requirements: Please see: https://eng.vt.edu/em

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 BSCPE and BSEE 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)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024, ECE 2514, ECE 2544, MATH 2214, and PHYS 2306
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Grade Requirement: Students must earn a C or higher in the following ECE courses: ECE 1004, ECE 2024, ECE 2214, ECE 2514, ECE 2544, ECE 2564, ECE 2714, ECE 2804.

Statement of Prerequisites: Pre-requisites for each course are listed after the course title. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. 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 131 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Machine Learning in-major GPA, all ECE courses, including repeats, are used.

FOCUS AREAS WITHIN ECE

The courses listed below are grouped into suggested ECE focus areas. Students are encouraged to choose 3 courses from a single focus area that is not their chosen major. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirement as long as at least one course (3 credits) is at the 4xxx level. **None of the 3 courses can duplicate a course from the student's major. 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 and prerequisite. Note: All ECE courses require a **C- or better** in prerequisite courses unless a C or better is noted on the checksheet.

CHIP-SCALE INTEGRATION

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE4514 (4)   DIGITAL DESIGN II, Pre: 3544

ECE4540 (3)   VLSI CIRCUIT DESIGN, Pre: 2214, 2544, 2804

CONTROLS, ROBOTICS, AND AUTONOMY

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3704 (3)   CONTINUOUS AND DISCRETE SYSTEMS, Pre: 2714, 2804

ECE3714 (3)   INTRODUCTION TO CONTROL SYSTEMS, Pre: 3704

ECE4524 (4)   ARTIFICIAL INTELLIGENCE AND ENGINEERING APPLICATIONS, Pre: 3514, STAT 4714

ECE4580 (3)   DIGITAL IMAGE PROCESSING, Pre: 2714, 2804

ECE4704 (3)   PRINCIPLES OF ROBOTICS SYSTEMS, Pre: 2714, 2804

NETWORKING AND CYBERSECURITY

ECE3564 (3)   INTRODUCTION TO COMPUTER NETWORKING, Pre: 2714, 2804, STAT 4714

ECE4560 (3)   COMPUTER AND NETWORK SECURITY FUNDAMENTALS, Pre: 3564 or CS 3214

ECE4564 (3)   NETWORK APPLICATION DESIGN, Pre: 3564, 3514

SOFTWARE SYSTEMS

ECE4524 (4)   ARTIFICIAL INTELLIGENCE AND ENGINEERING APPLICATIONS, Pre: 3514, STAT 4714

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

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

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

COMMUNICATIONS AND NETWORKING

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3564 (3)   INTRODUCTION TO COMPUTER NETWORKING, Pre: 2714, 2804, STAT 4714

ECE3614 (3)   INTRODUCTION TO COMMUNICATION SYSTEMS, Pre: 2714, 2804, STAT 4714

ECE3704 (3)   CONTINUOUS AND DISCRETE SYSTEMS, Pre: 2714, 2804

ECE4624 (3)   DIGITAL SIGNAL PROCESSING AND FILTER DESIGN, Pre: 3704

ECE4634 (3)   DIGITAL COMMUNICATIONS, Pre: 3614, STAT 4714

ENERGY AND POWER ELECTRONIC SYSTEMS

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3204 (3)   ANALOG ELECTRONICS, Pre: 2214, 2714, 2804

ECE3304 (3)   INTRODUCTION TO POWER SYSTEMS, Pre: 3004

ECE3704 (3)   CONTINUOUS AND DISCRETE SYSTEMS, Pre: 2714, 2804

ECE4205 (3)   ELECTRONIC CIRCUIT DESIGN, Pre: 2214, 2804

ECE4224 (3)   POWER ELECTRONICS, Pre: 3204, 3304

ECE4334 (3)   POWER SYSTEM ANALYSIS AND CONTROL, Pre: 3304

MICRO/NANOSYSTEMS

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3204 (3)   ANALOG ELECTRONICS, Pre: 2214, 2714, 2804

ECE3214 (3)   SEMICONDUCTOR DEVICE FUNDAMENTALS, Pre: (2214, 2804) or MSE 3204

ECE3614 (3)   INTRODUCTION TO COMMUNICATION SYSTEMS, Pre: 2714, 2804, STAT 4714

ECE4205 (3)   ELECTRONIC CIRCUIT DESIGN, Pre: 2214, 2804

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

ECE4234 (3)   SEMICONDUCTOR PROCESSING, Pre: (2214, 2804) or 3054

ECE4254 (3)   PRINCIPLES OF ELECTRONIC PACKAGING, Pre: (2214, 2804) or 2054 or 3054

PHOTONICS

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3106 (3)   ELECTROMAGNETIC FIELDS, Pre: 3105

ECE3134 (3)   INTRODUCTION OPTOELECTRONICS, Pre: 2214, 2804

ECE3614 (3)   INTRODUCTION TO COMMUNICATION SYSTEMS, Pre: 2714, 2804, STAT 4714

ECE4134 (3)   PHOTONICS, Pre: 3105

ECE4144 (3)   OPTICAL SYSTEMS, Pre: 3106

RADIO FREQUENCY AND MICROWAVE

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3106 (3)   ELECTROMAGNETIC FIELDS, Pre: 3105

ECE3204 (3)   ANALOG ELECTRONICS, Pre: 2214, 2714, 2804

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

ECE4104 (3)   MICROWAVE AND RF ENGINEERING, Pre: 3106, 3204

ECE4114 (3)   ANTENNAS, Pre: 3106

ECE4124 (3)   RADIO WAVE PROPAGATION, Pre: 3106

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

ECE4605 (3)   RADIO ENGINEERING, Pre: 3105, 3204, 3614

SPACE SYSTEMS

ECE3004 (3)   AC CIRCUIT ANALYSIS, Pre: 2714, 2804

ECE3104 (3)   INTRO SPACE SYSTEMS, Pre: 3105

ECE3105 (3)   ELECTROMAGNETIC FIELDS, Pre: 2214, 2804, (MATH 2204 or MATH 2204H or MATH 2406H), PHYS 2306

ECE3106 (3)   ELECTROMAGNETIC FIELDS, Pre: 3105

ECE3614 (3)   INTRODUCTION TO COMMUNICATION SYSTEMS, Pre: 2714, 2804, STAT 4714

ECE4154 (3)   INTRODUCTION TO SPACE WEATHER, Pre: 3106

ECE4164 (4)   INTRODUCTION TO GLOBAL POSITIONING SYSTEMS (GPS) THEORY AND DESIGN, Pre: 3106 or AOE 3154

ECE4194 (3)   ENGINEERING PRINCIPLES OF REMOTE SENSING, Pre: 3106

ECE4205 (3)   ELECTRONIC CIRCUIT DESIGN, Pre: 2214, 2804

ECE4644 (3)   SATELLITE COMMUNICATIONS, Pre: 3614

OTHER ECE OPTIONS (Actual course offerings will be based on sufficient resources)

ECE4324 (3)   MICROGRIDS, Pre: 3004

ECE4354 (3)   POWER SYSTEM PROTECTION, Pre: 4334

ECE4414 (3)   LINUX KERNEL PROGRAMMING, Pre: 3514, STAT 4714

ECE4444 (3)   TECHNOLOGICAL SINGULARITY

ECE4504 (3)   COMPUTER ORGANIZATION, Pre: 3504 or CS 3214

ECE4530 (3)   HARDWARE-SOFTWARE CODESIGN, Pre: 2564, 3544

ECE4534 (4)   EMBEDDED SYSTEM DESIGN, Pre: 2564, 3574

ECE4984 (3)   SPECIAL STUDY – TOPICS VARY (See timetable for options)

INDEPENDENT STUDIES AND UNDERGRADUATE RESEARCH

For purposes of satisfying the Secondary Focus requirements, the sum of the number of hours taken from ECE 4974 and 4994 cannot exceed 6 credits.

4974   (ARR)   Independent Study
4994   (ARR)   Undergraduate Research

Instructors and students must complete the College of Engineering Undergraduate Research/Independent Study Form (https://eng.vt.edu/academics/undergraduate-students/resources-support/undergraduate-research-independent-study.html). Deadline to submit form is last day to add classes.

INDIVIDUALIZED SECONDARY FOCUS (Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1) To begin this process, students must first meet with their academic advisor.
2) The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3) Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4) If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5) If the set of three courses are *not* part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6) It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.