COMPUTER ENGINEERING, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN AUTONOMY AND ARTIFICIAL INTELLIGENCE

Computer engineers are responsible for developing the powerful computer systems that have become a part of our everyday life. Applications for computer engineering span the spectrum from high-performance, general-purpose computing systems such as desktop workstations used in all facets of business, to small microprocessors embedded in larger systems and functioning as controllers. These latter applications, known as embedded systems, can be found in control systems for trains, aircraft and automobiles; medical equipment; telecommunications systems; and consumer electronics and appliances. This explosive growth of computer systems in use in almost every new appliance or vehicle has resulted in a strong demand for engineers trained in the development of these systems, and all indications are that this trend will continue for the foreseeable future.

Student learning outcomes

Upon completing this program, students will know and know how to do the following:

Computer engineering core outcomes

1. Identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. Communicate effectively with a range of audiences
4. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. Acquire and apply new knowledge as needed, using appropriate learning strategies

Autonomy and artificial intelligence concentration-specific outcome

1. Demonstrate a fundamental understanding of the application of AI in engineering systems and apply engineering techniques in the design of autonomous systems

Special requirements

Program D grade policy: Students must receive a minimum grade of C in all engineering, computer science, physics, mathematics and all technical electives to graduate.

Degree requirements for Computer Engineering, Bachelor of Science (B.S.)

Course	Title	Hours
General education (https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/)		
Select 30 credits of general education courses in consultation with an adviser.		30
Major requirements		
• Major core requirements		
CMSC 302	Introduction to Discrete Structures	3
EGRE 101	Introduction to Engineering	3
EGRE 201	Fundamentals of Electrical and Computer Engineering	3
EGRE 206	Electric Circuits	4
EGRE 207	Electric Circuits II	4
EGRE 245	Engineering Programming	4
EGRE 246	Advanced Engineering Programming	3
EGRE 254	Digital Logic Design	4
EGRE 335	Signals and Systems	4
EGRE 337	Statistical Information Processing	3
EGRE 399	Fundamentals of Design and Analysis	3
ENGR 395	Professional Development	1
• Additional major requirements		
Select one of the following sequences:		4
EGRE 404 & EGRE 405	Senior Design Studio I (Laboratory/Project Time) and Senior Design Studio II (Laboratory/Project Time)	
EGRE 406 & EGRE 407	Senior Design Studio I - VIP (Laboratory/Project Time) and Senior Design Studio II - VIP (Laboratory/Project Time)	
Math/science elective (see list below)		3
Technical and professional electives (see list and requirements below)		17
Concentration requirements		
EGRE 347	Applied Embedded Programming	3
EGRE 354	Introduction to Feedback Control Systems	3
EGRE 412	Introduction to Intelligent Autonomous Systems	3
EGRE 526	Computer Networks and Communications	3
CMSC 436	Artificial Intelligence	3
• Concentration electives		
Select concentration electives as described below		6
Ancillary requirements		
CHEM 101	General Chemistry I (satisfies general education BOK for natural sciences and SOI for scientific and logical reasoning)	3
or BIOL 151	Introduction to Biological Sciences I	

ECON 205	The Economics of Product Development and Markets (satisfies BOK for social/behavioral sciences and/or AOI for global perspectives)	3
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
MATH 201	Calculus with Analytic Geometry II	4
MATH 301	Differential Equations	3
MATH 310	Linear Algebra	3
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
PHYS 207 & PHYZ 207	University Physics I and University Physics I Laboratory (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
Open electives		
Select any course.		3
Total Hours		**127**

The minimum number of credit hours required for this degree is 127.

Capstone project (four credits)

The program culminates in the capstone project. In order to prepare for the appropriate focus area of the capstone project, students, with the help of their academic adviser, should plan a course of study beginning in the fall semester of their junior year.

Concentration electives

Computer engineering students completing the autonomy and artificial intelligence concentration will choose two elective courses from the following list. A special topic, independent study or other course may be used as a concentration elective with prior written approval of the department chair.

Course	Title	Hours
EGRE 444	Communication Systems	3
EGRE 455	Control Systems Design	3
EGRE 510	Introduction to Internet of Things	3
EGRE 513	Fundamentals of Modern Systems Engineering	3
EGRE 532	GPU Computing	3
EGRE 536	Introduction to Cyber-Physical Systems	3
CMSC 401	Algorithm Analysis with Advanced Data Structures	3
CMSC 410	Introduction to Quantum Computing	3
CMSC 438	Machine Learning	3

Math/science electives

Students must complete three credits using one course or a combination of courses from the list below. A course can not be used to meet both an ancillary requirement and the math/science elective requirement.

Course	Title	Hours
BIOL 151	Introduction to Biological Sciences I	3
BIOZ 151	Introduction to Biological Science Laboratory I	1
BIOL 152	Introduction to Biological Sciences II	3
BIOZ 152	Introduction to Biological Science Laboratory II	1
CHEM 101	General Chemistry I	3
CHEZ 101	General Chemistry Laboratory I	1
CHEM 102	General Chemistry II	3
CHEZ 102	General Chemistry Laboratory II	1
MATH 300	Introduction to Mathematical Reasoning	3
MATH 305	Elementary Number Theory	3
MATH 324	Mathematical Problem Solving	3
MATH 350	Introductory Combinatorics	3
MATH 356	Graphs and Algorithms	3
MATH 370	Mathematical Foundations for Artificial Intelligence	3
PHYS 208	University Physics II	4
PHYZ 208	University Physics II Laboratory	1
PHYS 301	Classical Mechanics I	3
PHYS 302	Classical Mechanics II	3
PHYS 320	Modern Physics	3
PHYZ 320	Modern Physics Laboratory	1

Technical and professional electives

Students must complete a combined total of 17 credits of technical and professional electives. No more than nine credits of professional electives may apply toward this total.

Technical electives

Technical electives in the junior and senior year must be chosen from the approved lists. The following criteria must be met:

- At least six credit hours must come from the electrical and computer engineering or computer science areas
- Courses not from the approved lists must be approved by the adviser and department chair.
- Courses must be technical courses at the 300 level or above.
- No more than three credit hours may come from independent study courses.
- If a student wants to apply ENGR 497 toward their technical electives, a minimum of four credit hours must be earned.
- A maximum of eight credits of ENGR 494, ENGR 497 and independent study courses may be used toward technical electives.

Note: Some of the listed courses may have prerequisites that do not count as technical electives.

Course	Title	Hours
Approved electives in electrical and computer engineering		
EGMN 315	Process and Systems Dynamics	3
EGMN 427	Robotics	3
EGRE 303	Electronic Devices	3
EGRE 307	Integrated Circuits	4

EGRE 309	Introduction to Electromagnetic Fields	3
EGRE 310	Electromagnetic Fields and Waves	3
EGRE 334	Introduction to Microfabrication	4
EGRE 336	Introduction to Communication Systems	3
EGRE 371	Introduction to Power Systems	3
EGRE 435	Microscale and Nanoscale Fabrication	4
EGRE 436	Advanced Microscale and Nanoscale Fabrication	3
EGRE 444	Communication Systems	3
EGRE 454	Automatic Controls	4
EGRE 455	Control Systems Design	3
EGRE 471	Power System Analysis	3
EGRE 510	Introduction to Internet of Things	3
EGRE 512	Intelligent Autonomous Systems	3
EGRE 521	Advanced Semiconductor Devices	3
EGRE 525	Fundamentals of Photonics Engineering	3
EGRE 526	Computer Networks and Communications	3
EGRE 531	Multicore and Multithreaded Programming	3
EGRE 532	GPU Computing	3
EGRE 535	Digital Signal Processing	3
EGRE 536	Introduction to Cyber-Physical Systems	3
EGRE 539	Introduction to Microwave Engineering	3
EGRE 540	Microwave System Design	3
EGRE 541	Medical Devices	3
EGRE 553	Industrial Automation	3
EGRE 554	Advanced Industrial Automation	3
EGRE 573	Sustainable and Efficient Power Systems	3
Approved electives in computer science		
CMSC 303	Introduction to the Theory of Computation	3
CMSC 355	Fundamentals of Software Engineering	3
CMSC 401	Algorithm Analysis with Advanced Data Structures	3
CMSC 404	Compiler Construction	3
CMSC 411	Computer Graphics	3
CMSC 420	Software Project Management	3
Approved electives outside of electrical and computer engineering and computer science		
EGMN 309	Material Science for Engineers	3
EGMN 321	Numerical Methods	3
EGRB 407	Physical Principles of Medical Imaging	3
EGRB 408	Advanced Biomedical Signal Processing	3
EGRB 507	Biomedical Electronics and Instrumentation	3
ENGR 497	Vertically Integrated Projects	0-2
MATH 307	Multivariate Calculus	4
PHYS 307	The Physics of Sound and Music	3
PHYS 320	Modern Physics	3
PHYZ 320	Modern Physics Laboratory	1

Professional electives

Professional electives are satisfied by completing courses that meet all four of the following criteria:

1. One of the following course rubrics: ACCT, ANAT, BIOC, BIOL, BIOS, BNFO, BUSN, CHEM, ECON, ENVS, FIRE, HSEP, INFO, INNO, INSC, LFSC, MATH, MGMT, MILS, MKTG, NANO, OPER, PHIS, PHYS, STAT, SCMA, VNTR.
2. Not otherwise required for the major by the effective bulletin
3. 300 level or higher
4. Three or more credit hours

In addition, EGMN 110 and EGMN 204 may be used as professional electives.

Other courses may be used to satisfy technical or professional elective requirements with prior written approval from the department chair.

All courses used to satisfy technical or professional elective requirements must be completed with a minimum grade of C.

Recommended course sequence/plan of study

Freshman year

Fall semester		**Hours**
CHEM 101 or BIOL 151	General Chemistry I (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning) or Introduction to Biological Sciences I	3
EGRE 101	Introduction to Engineering	3
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
UNIV 111 Play course video for Introduction to Focused Inquiry: Investigation and Communicatio	Introduction to Focused Inquiry: Investigation and Communication (satisfies general education UNIV foundations)	3
General education course (select AOI for creativity, innovation and aesthetic inquiry)		3
	Term Hours:	**16**
Spring semester		
EGRE 201	Fundamentals of Electrical and Computer Engineering	3
EGRE 254	Digital Logic Design	4
MATH 201	Calculus with Analytic Geometry II	4
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations)	3
General education course		3
	Term Hours:	**17**

Sophomore year

Fall semester		
EGRE 206	Electric Circuits	4
EGRE 245	Engineering Programming	4
ENGR 395	Professional Development	1
MATH 301	Differential Equations	3
PHYS 207 & PHYZ 207	University Physics I and University Physics I Laboratory (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
	Term Hours:	**17**
Spring semester		
EGRE 207	Electric Circuits II	4
EGRE 246	Advanced Engineering Programming	3
EGRE 335	Signals and Systems	4
EGRE 337	Statistical Information Processing	3
MATH 310	Linear Algebra	3
	Term Hours:	**17**
Junior year		
Fall semester		
CMSC 302	Introduction to Discrete Structures	3
EGRE 347	Applied Embedded Programming	3
EGRE 354	Introduction to Feedback Control Systems	3
CMSC 436	Artificial Intelligence	3
Technical and professional elective		3
	Term Hours:	**15**
Spring semester		
EGRE 399	Fundamentals of Design and Analysis	3
EGRE 412	Introduction to Intelligent Autonomous Systems	3
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
Concentration elective		3
Technical and professional elective		3
	Term Hours:	**15**
Senior year		
Fall semester		
ECON 205	The Economics of Product Development and Markets (satisfies BOK for social/behavioral sciences and/or AOI for global perspectives)	3
EGRE 404 or EGRE 406	Senior Design Studio I (Laboratory/Project Time) or Senior Design Studio I - VIP (Laboratory/Project Time)	2
EGRE 526	Computer Networks and Communications	3
Concentration elective		3
Technical and professional elective		4
	Term Hours:	**15**
Spring semester		
EGRE 405 or EGRE 407	Senior Design Studio II (Laboratory/Project Time) or Senior Design Studio II - VIP (Laboratory/Project Time)	2
Math/science elective		3
Technical and professional electives		7
Open elective		3
	Term Hours:	**15**
	Total Hours:	**127**

The minimum number of credit hours required for this degree is 127.