ELECTRICAL ENGINEERING, BACHELOR OF SCIENCE (B.S.) WITH A CONCENTRATION IN POWER AND ENERGY SYSTEMS

The profession of electrical engineering touches all aspects of our lives in that electrical engineers design and fabricate devices and systems critical in applications such as computing, communications, health care, manufacturing and automation, power generation and utilization, transportation, and entertainment. An element very important to these and many other applications is the microelectronic device or system.

In the sub-area of microelectronics, electrical engineers design and fabricate electronic materials such as semiconductors, conductors and superconductors used in the manufacture of electronic devices. As a natural progression, electrical engineers design and fabricate electronic devices such as transistors, which control or modulate the flow of energy; sensors of light, mechanical force, chemicals, etc.; electromagnetic radiation sources such as lasers, light emitting diodes and microwave power sources. Following this progression, we find electrical engineers designing and fabricating integrated circuits such as microprocessors and memory elements; flat-panel displays, etc., which are found in applications ranging from supercomputers to watches, clocks and toys. Further in this progression we find electrical engineers designing and fabricating today's and tomorrow's computers.

Computer systems and application-specific integrated circuits are the elements that enable the existence of today's communication systems, such as the Internet, satellite systems, telemedicine, wired and wireless (cellular) telephones, along with standard and high definition television. Additionally, along with sensors, microwave power sources and actuators, they permit our present and future automated manufacturing lines, air and traffic control systems, and automotive safety and traffic control through collision avoidance radar systems, antilocking brake systems, air bag actuators, automatic traffic routing and the "smart highway" of the future.

Electrical engineers play an ever increasing role in the design and building of major facets of today's and tomorrow's health care systems and medical research through the application of microelectronic instrumentation and diagnostic tools such as MRI and CAT scan systems. The field of electrical engineering truly permeates every facet of our lives and thus provides excellent employment opportunities to the general practitioner or specialist in more than 35 different subspecialties.

Student learning outcomes

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

Electrical 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

Power and energy systems concentration-specific outcome

1. Demonstrate a fundamental understanding of the design and analysis of power and energy 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 Electrical 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		
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)		16
Concentration requirements		

EGRE 309	Introduction to Electromagnetic Fields	3
EGRE 354	Introduction to Feedback Control Systems	3
EGRE 371	Introduction to Power Systems	3
EGRE 471	Power System Analysis	3
EGRE 573	Sustainable and Efficient Power Systems	3
• Concentration electives		
Select concentration electives as described below		6-8
Ancillary requirements		
CHEM 101	General Chemistry I (satisfies BOK for natural sciences and AOI for scientific and logical reasoning)	3
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 307	Multivariate Calculus	4
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

Electrical engineering students completing the power and energy systems 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 306	Introduction to Microelectronics	4
EGRE 310	Electromagnetic Fields and Waves	3
EGRE 336	Introduction to Communication Systems	3
EGRE 347	Applied Embedded Programming	3
EGRE 364	Microcomputer Systems	4
EGRE 365	Digital Systems	4
EGRE 429	Advanced Digital Systems Design and Analysis	3
EGRE 455	Control Systems Design	3
EGRE 510	Introduction to Internet of Things	3
EGRE 513	Fundamentals of Modern Systems Engineering	3
EGRE 526	Computer Networks and Communications	3
EGRE 536	Introduction to Cyber-Physical Systems	3

Math/science electives

Students must complete 3 credits using one course or a combination of courses from the list below.

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
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 16 credits of technical and professional electives. No more than eight 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 be from approved electrical engineering electives.
- 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 the 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 electrical engineering electives		
EGMN 315	Process and Systems Dynamics	3
EGMN 427	Robotics	3
EGRE 307	Integrated Circuits	4
EGRE 334	Introduction to Microfabrication	4
EGRE 347	Applied Embedded Programming	3
EGRE 365	Digital Systems	4
EGRE 371	Introduction to Power Systems	3
EGRE 426	Computer Organization and Design	3
EGRE 428	Introduction to Integrated Systems Design	2
EGRE 429	Advanced Digital Systems Design and Analysis	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 513	Fundamentals of Modern Systems Engineering	3
EGRE 521	Advanced Semiconductor Devices	3
EGRE 525	Fundamentals of Photonics Engineering	3
EGRE 526/CMSC 506	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 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 outside electrical engineering		
CMSC 355	Fundamentals of Software Engineering	3
CMSC 405	Operating Systems	3
CMSC 420	Software Project Management	3
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 494	Intern or Co-op for Credit	3
ENGR 497	Vertically Integrated Projects	1,2
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	General Chemistry I (satisfies BOK for natural sciences and AOI for scientific and logical reasoning)	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 science 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		
MATH 307	Multivariate Calculus	4
EGRE 354	Introduction to Feedback Control Systems	3
EGRE 371	Introduction to Power Systems	3
Concentration elective		3-4
Technical and professional elective		3
	Term Hours:	**16**
Spring semester		
EGRE 399	Fundamentals of Design and Analysis	3
EGRE 309	Introduction to Electromagnetic Fields	3
EGRE 471	Power System Analysis	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		3-4
	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 573	Sustainable and Efficient Power Systems	3
Technical and professional electives		6
	Term Hours:	**14**
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.