Computer Engineering

Degree Offered

• Bachelor of Science in Computer Engineering (B.S.Cp.E.)

Nature of the Program

Computer engineers design, develop, test, and oversee the manufacture and maintenance of embedded computer hardware and software. As such, computer engineering combines portions of the knowledge of electrical engineers and computer scientists. Embedded computer systems include applications in the automotive, communications, radio and television, consumer electronics, aircraft, robotics, and health-care industries. In addition, computer engineers design, develop, test, manufacture, and maintain complex systems including digital communications systems such as cell phone networks, secure computer networks, and system-level software such as operating systems and applications software. The computer engineering program is accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org.

Program Educational Objectives

The Program Educational Objectives (PEO) of the Computer Engineering (CpE) program at West Virginia University is to produce graduates who will apply their knowledge and skills to achieve success in their careers in industry, research, government service or graduate study. It is expected that in the first five years after graduation our graduates will achieve success and proficiency in their profession, be recognized as leaders, and contribute to the well-being of society.

Student Outcomes

Upon graduation, all Bachelor of Science in Computer Engineering students will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to 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. An ability to communicate effectively with a range of audiences
4. An ability to 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. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Fundamental courses in the computer engineering areas of hardware and software are taken during the second year with general fundamental engineering courses included. The third and fourth years in the curriculum concentrate on areas of computer engineering in both software and hardware with technical electives provided to allow the student to acquire more depth in a preferred area of expertise.

The computer engineering technical electives must be taken from 400-level CPE regular courses. The other technical electives should be selected from upper division regular courses in biometric systems, computer engineering, computer science, or electrical engineering. However, students with special career objectives can petition the department through their advisors for prior written permission to select technical electives from upper-division courses in mathematics, the sciences, or other areas of engineering.

A total of five humanities and social science electives (GEF electives) must be selected. The humanities and social science electives must be chosen so as to meet the University General Education Foundations requirements and Accreditation Board for Engineering and Technology accreditation guidelines.

Click here to view the Suggested Plan of Study (p. 3)

Curriculum in Computer Engineering

General Education Foundations

Please use this link to view a list of courses that meet each GEF requirement. (http://registrar.wvu.edu/gef)

NOTE: Some major requirements will fulfill specific GEF requirements. Please see the curriculum requirements listed below for details on which GEFs you will need to select.

General Education Foundations

F1 - Composition & Rhetoric
ENGL 101 & ENGL 102
or ENGL 103
F2A/F2B - Science & Technology
F3 - Math & Quantitative Reasoning
F4 - Society & Connections
F5 - Human Inquiry & the Past
F6 - The Arts & Creativity
F7 - Global Studies & Diversity
F8 - Focus (may be satisfied by completion of a minor, double major, or dual degree)
Total Hours

Please note that not all of the GEF courses are offered at all campuses. Students should consult with their advisor or academic department regarding the GEF course offerings available at their campus.

Curriculum Requirements

To receive a bachelor of science in computer engineering, a student must meet the University’s undergraduate degree requirements, take all the courses indicated below, and attain a grade point average of 2.25 or better for all Lane Department of Computer Science and Electrical Engineering courses, in all WVU courses, and overall. If a Lane Department of Computer Science and Electrical Engineering is repeated, only the last grade received is used to compute the major grade point average, and the course credit hours are counted only once. This requirement assures that the student has demonstrated overall competence in the major.

Freshman Engineering Requirements

ENGR 101 Engineering Problem Solving 1 2
Engineering Problem Solving:
CHE 102 Introduction to Chemical Engineering 3
ENGR 102 Engineering Problem-Solving 2
ENGR 103 Introduction to Nanotechnology Design
MAE 102 Introduction to Mechanical and Aerospace Engineering Design
ENGR 191 First-Year Seminar 1

Non-Computer Engineering Core

CHEM 115 Fundamentals of Chemistry 4
& 115L and Fundamentals of Chemistry 1 - Laboratory (GEF 2B)
ECON 201 Principles of Microeconomics (GEF 4) 3
ECON 202 Principles of Macroeconomics 3

Calculus I (GEF 3):
MATH 155 Calculus 1 (Minimum grade of C- is required) 4
MATH 153 Calculus 1a with Precalculus
& MATH 154 and Calculus 1b with Precalculus (Minimum grade of C- is required)
MATH 156 Calculus 2 (GEF 8 - Minimum grade of C- is required) 4
MATH 251 Multivariable Calculus (Minimum grade of C- is required) 4
MATH 261 Elementary Differential Equations 4
MATH 375 Applied Modern Algebra 3
PHYS 111 General Physics (GEF 8) 4
PHYS 112 General Physics (GEF 8) 4
STAT 215 Introduction to Probability and Statistics 3

Engineering Science Elective (Choose one) 3

Computer Engineering Core Requirements (Minimum GPA of 2.0 required in BIOM, CPE, CS, and EE courses)

CPE 271 Introduction to Digital Logic Design 3
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 272</td>
<td>Digital Logic Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CPE 310</td>
<td>Microprocessor Systems</td>
<td>3</td>
</tr>
<tr>
<td>CPE 311</td>
<td>Microprocessor Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CPE 312</td>
<td>Microcomputer Structures and Interfacing</td>
<td>3</td>
</tr>
<tr>
<td>CPE 313</td>
<td>Microcomputer Structures and Interfacing Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CPE 480</td>
<td>Capstone Project - Design (Fulfills Writing and Communications Skills Requirement)</td>
<td>2</td>
</tr>
<tr>
<td>CPE 481</td>
<td>Capstone Project - Implementation</td>
<td>3</td>
</tr>
<tr>
<td>CS 110</td>
<td>Introduction to Computer Science</td>
<td>4</td>
</tr>
<tr>
<td>CS 111</td>
<td>Introduction to Data Structures</td>
<td>4</td>
</tr>
<tr>
<td>CS 230</td>
<td>Introduction to Software Engineering</td>
<td>4</td>
</tr>
<tr>
<td>CS 350</td>
<td>Computer System Concepts</td>
<td>3</td>
</tr>
<tr>
<td>CS 450</td>
<td>Operating Systems Structure</td>
<td>3</td>
</tr>
<tr>
<td>EE 221</td>
<td>Introduction to Electrical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>EE 222</td>
<td>Introduction to Electrical Engineering Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>EE 223</td>
<td>Electrical Circuits</td>
<td>3</td>
</tr>
<tr>
<td>EE 224</td>
<td>Electrical Circuits Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>EE 225</td>
<td>Digital Electronics</td>
<td>3</td>
</tr>
<tr>
<td>EE 226</td>
<td>Signals and Systems 1</td>
<td>3</td>
</tr>
<tr>
<td>EE 355</td>
<td>Analog Electronics</td>
<td>3</td>
</tr>
<tr>
<td>EE 356</td>
<td>Analog Electronics Laboratory</td>
<td>1</td>
</tr>
<tr>
<td>CPE Technical Elective (400-level course in Computer Engineering)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Technical Electives (300 level or higher course in Biometric Systems, Computer Engineering, Computer Science, or Electrical Engineering)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Free Elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>GEF Electives 1, 5, 6, 7</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Total Hours 130

### Suggested Plan of Study

It is important for students to take courses in the order specified as much as possible; all prerequisites and concurrent requirements must be observed. A typical B.S.Cp.E. degree program that completes degree requirements in four years is as follows.

#### First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 155 (GEF 3)</td>
<td>4 MATH 156 (GEF 8)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>ENGR 101</td>
<td>2 ENGR 102</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ENGR 191</td>
<td>1 PHYS 111 (GEF 8)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>CHEM 115</td>
<td>4 GEF 6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>&amp; 115L (GEF 2)</td>
<td>3 GEF 7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ENGL 101 (GEF 1)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GEF 5</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>17</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 271</td>
<td>3 CS 110</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>CPE 272</td>
<td>1 EE 223′</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>EE 221</td>
<td>3 EE 224′</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EE 222</td>
<td>1 EE 251</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MATH 251</td>
<td>4 EE 252′</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PHYS 112 (GEF 8)</td>
<td>4 ENGL 102 (GEF 1)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MATH 261</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16</strong></td>
<td><strong>19</strong></td>
<td></td>
</tr>
</tbody>
</table>
Third Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 310</td>
<td>3</td>
<td>CPE 312*</td>
<td>3</td>
</tr>
<tr>
<td>CPE 311</td>
<td>1</td>
<td>CPE 313*</td>
<td>1</td>
</tr>
<tr>
<td>CS 111</td>
<td>4</td>
<td>CS 230</td>
<td>4</td>
</tr>
<tr>
<td>EE 327*</td>
<td>3</td>
<td>CS 350</td>
<td>3</td>
</tr>
<tr>
<td>EE 355*</td>
<td>3</td>
<td>ECON 201 (GEF 4)</td>
<td>3</td>
</tr>
<tr>
<td>EE 356*</td>
<td>1</td>
<td>STAT 215</td>
<td>3</td>
</tr>
<tr>
<td>MATH 375</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18       17

Fourth Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPE 480</td>
<td>2</td>
<td>CPE 481</td>
<td>3</td>
</tr>
<tr>
<td>CS 450</td>
<td>3</td>
<td>Engr. Science Elective</td>
<td>3</td>
</tr>
<tr>
<td>ECON 202</td>
<td>3</td>
<td>CPE Tech. Elective</td>
<td>3</td>
</tr>
<tr>
<td>Free Elective</td>
<td>3</td>
<td>Tech. Elective</td>
<td>3</td>
</tr>
<tr>
<td>Tech. Elective</td>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14       12

Total credit hours: 130

* Offered once per year in the semester shown.

AREA OF EMPHASIS IN CYBERSECURITY

A minimum grade of C- is required in each course.

- CS 453 Data and Computer Communications 3
- CS 465 Cybersecurity Principles and Practice 3
- CYBE 366 Secure Software Development 3
- CYBE 467 Practicing Cybersecurity: Attacks & Countermeasures 3

Select one of the following: 3

- CPE 435 Computer Incident Response
- CYBE 466 Host Based Cyber Defense

Total Hours 15

Major Learning Outcomes

COMPUTER ENGINEERING

Program Educational Objectives

The Program Educational Objectives (PEO) of the Computer Engineering (CpE) program at West Virginia University is to produce graduates who will apply their knowledge and skills to achieve success in their careers in industry, research, government service or graduate study. It is expected that in the first five years after graduation our graduates will achieve success and proficiency in their profession, be recognized as leaders, and contribute to the well-being of society.

Student Outcomes

Upon graduation, all Bachelor of Science students in Computer Engineering will have:

1. An ability to apply knowledge of mathematics, science, and engineering
2. An ability to design and conduct experiments, as well as to analyze and interpret data
3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. An ability to function on multidisciplinary teams
5. An ability to identify, formulate, and solve engineering problems
6. An understanding of professional and ethical responsibility
7. An ability to communicate effectively
8. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
9. A recognition of the need for, and an ability to engage in life-long learning
10. A knowledge of contemporary issues
11. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

**CPE 191. First-Year Seminar. 1-3 Hours.**
Engages students in active learning strategies that enable effective transition to college life at WVU. Students will explore school, college and university programs, policies and services relevant to academic success. Provides active learning activities that enable effective transition to the academic environment. Students examine school, college and university programs, policies and services.

**CPE 271. Introduction to Digital Logic Design. 3 Hours.**
PR: MATH 156 or consent. Introduction to the design of digital systems. Topics include number systems, coding, Boolean and switching algebra, minimization of logic, analysis and design of combinational and sequential logic circuits.

**CPE 272. Digital Logic Laboratory. 1 Hour.**
CoReq: CPE 271. Experiments with digital electronic circuits including number systems, design and application of modern digital circuitry for both combinational and sequential logic circuits. (3 hr. lab.).

**CPE 293. Special Topics. 1-6 Hours.**
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

**CPE 310. Microprocessor Systems. 3 Hours.**
PR: CPE 271 and CPE 272 and PR or CONC: CPE 311. Theory and design of microprocessors: organization and architecture of modern processors; integration of microprocessors with RAM, ROM, and I/O devices; machine language, assembly language and software development. (3 hr. lec.).

**CPE 311. Microprocessor Laboratory. 1 Hour.**
CoReq: CPE 310. Machine language, assembly language and hardware and software interfacing. (This includes editing, linking, and debugging.) Memory, I/O and basic techniques of microprocessor interfacing. (3 hr. lab.).

**CPE 312. Microcomputer Structures and Interfacing. 3 Hours.**
PR: CPE 310 and CPE 311 and EE 251 and EE 252 and CoReq: CPE 313 and CS 350. Design of computer systems with emphasis on interface hardware including communications, high power interface devices, line driver/receiver circuits, A/D and D/A devices, and utilization of software techniques for programmed, interrupted, and direct memory access. (3 hr. lec.).

**CPE 313. Microcomputer Structures and Interfacing Laboratory. 1 Hour.**
PR: CPE 310 and CPE 311 and CoReq: CPE 312. A microprocessor based single-board computer is designed and built. A semester project is required using standard I/O techniques. (3 hr. lab.).

**CPE 412. Mobile Robotics. 3 Hours.**
PR: Consent. Introduction to fundamental topics in Mobile robotics; methods of locomotion; common mobile robot sensors, state estimation and navigation algorithms; path planning and obstacle avoidance methods; robot decision making and control processes; and mobile robot systems design.

**CPE 435. Computer Incident Response. 3 Hours.**
PR: (MATH 375 or MATH 378) and (CPE 310 or CPE 320). Control, data, and demand-driven computer architecture; parallel processing, pipelining, and vector processing; structures and algorithms for array processors, systolic architectures, design of architectures. (3 hr. lec.).

**CPE 442. Introduction to Digital Computer Architecture. 3 Hours.**
PR: EE 327 and (STAT 215 or MATH 448). Design and analysis of modern wireless data networks. Digital modulation techniques, wireless channel models, design of cellular networks, spread spectrum, carrier sense multiple access, ad-hoc networks routing, error control coding, automatic request strategies.

**CPE 480. Capstone Project - Design. 2 Hours.**
PR: ENGL 102 or ENGL 103 and consent. Penultimate semester group senior design projects with individual design assignments appropriate to student's discipline. Complete system-level designs of the subsequent semester's project presented in written proposals and oral presentations. (Equivalent to BIOM 480, CS 480, and EE 480). (2 hr. lec., 1 hr. conf.).

**CPE 481. Capstone Project - Implementation. 3 Hours.**
PR: CPE 480. Continuation of CPE 480. Detailed design and implementation of the system including choice of components, algorithm development, interfacing troubleshooting, working in groups, and project management. Also covers professional topics, including ethics, liability, safety, socio-legal issues, risks and employment agreements. (1 hr. lec., 1 hr. conf., 2 hr. lab.).

**CPE 484. Real-Time Systems Development. 3 Hours.**
PR: CS 350 or working knowledge of C programming language and UNIX. Characteristics of real-time systems, system and software development standards, structured and object oriented development methods for real-time systems, using a computer aided software engineering (CASE) tool in the development of a large engineering project. Emphasis is on real-time systems requirements analysis and design. This is a project based course. (3 hr. lec.).
CPE 490. Teaching Practicum. 1-3 Hours.
PR: Consent. Teaching practice as a tutor or assistant.

CPE 491. Professional Field Experience. 1-18 Hours.
PR: Consent. (May be repeated up to a maximum of 18 hours.) Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

CPE 493. Special Topics. 1-6 Hours.
PR: Consent. Investigation of topics not covered in regularly scheduled courses.

CPE 494. Seminar. 1-3 Hours.
PR: Consent. Presentation and discussion of topics of mutual concern to students and faculty.

CPE 495. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

CPE 496. Senior Thesis. 1-3 Hours.
PR: Consent.

CPE 498. Honors. 1-3 Hours.
PR: Students in Honors Program and consent by the honors director. Independent reading, study or research.