**Computer Engineering**

**Nature of 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 students in Computer Engineering will have the:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- 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
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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 |  | 3-6 |
Computer Engineering

ENGL 101 Introduction to Composition and Rhetoric
& ENGL 102 and Composition, Rhetoric, and Research
or ENGL 103 Accelerated Academic Writing

F2A/F2B - Science & Technology 4-6
F3 - Math & Quantitative Skills 3-4
F4 - Society & Connections 3
F5 - Human Inquiry & the Past 3
F6 - The Arts & Creativity 3
F7 - Global Studies & Diversity 3
F8 - Focus (may be satisfied by completion of a minor, double major, or dual degree) 9

Total Hours 31-37

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 2
ENGR 103 Introduction to Nanotechnology Design 3
MAE 102 Introduction to Mechanical and Aerospace Engineering Design 3
ENGR 191 First-Year Seminar 1

Non-Computer Engineering Core

CHEM 115 Fundamentals of Chemistry (GEF 2B) 4
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 and Calculus 1b with Precalculus
& MATH 154 (Minimum grade of C- is required) 4
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
CHE 201 Material and Energy Balances 1
CHE 366 Materials Science
IENG 377 Engineering Economy
MAE 241 Statics
MAE 320 Thermodynamics

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
CPE 272 Digital Logic Laboratory 1
### CPE 310 Microprocessor Systems 3
- CPE 311 Microprocessor Laboratory 1
- CPE 312 Microcomputer Structures and Interfacing 3
- CPE 313 Microcomputer Structures and Interfacing Laboratory 1
- CPE 480 Capstone Project - Design (Fulfills Writing and Communications Skills Requirement) 2
- CPE 481 Capstone Project - Implementation 3
- CS 110 Introduction to Computer Science 4
- CS 111 Introduction to Data Structures 4
- CS 230 Introduction to Software Engineering 4
- CS 350 Computer System Concepts 3
- CS 450 Operating Systems Structure 3
- EE 221 Introduction to Electrical Engineering 3
- EE 222 Introduction to Electrical Engineering Laboratory 1
- EE 223 Electrical Circuits 3
- EE 224 Electrical Circuits Laboratory 1
- EE 251 Digital Electronics 3
- EE 252 Digital Electronics Laboratory 1
- EE 327 Signals and Systems 1 3
- EE 355 Analog Electronics 3
- EE 356 Analog Electronics Laboratory 1
- CPE Technical Elective (400-level course in Computer Engineering) 3
- Technical Electives (300 level or higher course in Biometric Systems, Computer Engineering, Computer Science, or Electrical Engineering) 6
- Free Elective 3
- GEF Electives 1, 5, 6, 7 15

**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>
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<tbody>
<tr>
<td>MATH 155 (GEF 3)</td>
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<td>MATH 156 (GEF 8)</td>
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<td>ENGR 102</td>
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<td>ENGR 191</td>
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<td>PHYS 111 (GEF 8)</td>
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<td>CHEM 115 (GEF 2)</td>
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<td>GEF 6</td>
<td>3</td>
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<td>GEF 7</td>
<td>3</td>
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<tr>
<td>GEF 5</td>
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#### Second Year

<table>
<thead>
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<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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<tbody>
<tr>
<td>CPE 271</td>
<td>3</td>
<td>CS 110</td>
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<tr>
<td>CPE 272</td>
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<td>EE 223</td>
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<tr>
<td>MATH 251</td>
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<td>EE 252</td>
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<tr>
<td>PHYS 112 (GEF 8)</td>
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<td>ENGL 102 (GEF 1)</td>
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<td>MATH 261</td>
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</table>

#### Third Year

<table>
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<th>Fall</th>
<th>Hours</th>
<th>Spring</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>CPE 310</td>
<td>3</td>
<td>CPE 312</td>
<td>3</td>
</tr>
</tbody>
</table>

### Notes
- GEF Electives 1, 5, 6, 7
- Technical Electives (300 level or higher course in Biometric Systems, Computer Engineering, Computer Science, or Electrical Engineering)
- Free Electives
- CPE Technical Elective (400-level course in Computer Engineering)
- Total 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:  
- CPE 435  Computer Incident Response  3
- CYBE 466  Host Based Cyber Defense  3

Total Hours  15

**Major Learning Outcomes**

**COMPUTER ENGINEERING**

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- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
• A knowledge of contemporary issues
• An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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 CoReg: 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, interrupt, 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: CPE 310 and CPE 311 and (CS 350 or CS 355) or consent. Introduction to computer incident response, forensics, and computer security. Legal basis, proper procedures, and multiple operating systems application.

CPE 442. Introduction to Digital Computer Architecture. 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 462. Wireless Networking. 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.