COMPUTER ENGINEERING, B.S. (ENGINEERING)

Begin Campus: Any Penn State Campus
End Campus: University Park

Program Description
The mission of the faculty of the undergraduate computer engineering program at Penn State is to provide students with the knowledge and experience needed to pursue a productive lifelong career in industry or to engage in further study at the graduate level. Students participate in a balanced program of instruction covering the basic principles of the design and application of computer systems. The program includes coverage in breadth and depth of basic science, engineering, and abstract concepts of information handling. Students specialize in and are prepared for careers in the design, analysis and use of hardware, software and systems. The program is structured to ensure that graduates have a clear understanding of the design and the applications of computers, as well as the ability to apply this knowledge throughout their professional careers.

What is Computer Engineering?
Computer engineering is the study of the design, analysis, and implementation of computer systems including processors, memory, embedded devices, and data communication systems for a wide range of application domains. It includes the study of digital systems, computer architecture, and computer networks. It encompasses many design activities spanning from designing individual logic components to designing complete computer systems composed of hardware, software, and hardware-software co-design. Computer engineering drives the development of new computing systems that enable the latest technologies impacting our everyday lives.

You Might Like This Program If...
• You excel in math and physics and have an interest in designing and constructing computer hardware
• You want to build and analyze physical computing devices that go beyond traditional computers
• You want to understand how current computer hardware and software work and how to design the next generation hardware and its supporting software
• You want to design computing systems that impact and improve everyday lives

Entrance to Major
This program currently has administrative enrollment controls. Administrative Enrollment Controls are initiated when limitations of space, faculty, or other resources in a major prevent accommodating all students who request them. Students must follow the administrative enrollment controls that are in effect for the semester that they enter the university.

First-Year Students Entering Summer 2022, Fall 2022, Spring 2023
In order to be eligible for entrance to this major, students must satisfy the following requirements:

• 29-55 graded Penn State credits (excludes transfer and AP credits)
• completed with a grade of C or better: CMPSC 121 or CMPSC 131, CHEM 110, MATH 140, MATH 141, PHYS 211
• earned a minimum cumulative grade-point average (GPA) of 3.00

Students Who Entered Prior to Summer 2022
Students who entered the University from Summer 2018 through Spring 2022 should view the administrative enrollment controls in the appropriate Undergraduate Bulletin archive (https://bulletins.psu.edu/undergraduate/archive/). Students who entered the University prior to the summer 2018 semester should consult with their academic adviser about the administrative enrollment controls in effect for the semester they entered the university.

Degree Requirements
For the Bachelor of Science degree in Computer Engineering, a minimum of 128 credits is required:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Education</td>
<td>45</td>
</tr>
<tr>
<td>Requirements for the Major</td>
<td>110</td>
</tr>
</tbody>
</table>

27 of the 45 credits for General Education are included in the Requirements for the Major. This includes: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.

Requirements for the Major
To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44).

Code | Title                                                      | Credits |
-----|------------------------------------------------------------|---------|
CMPEN 362 | Communication Networks                                   | 3       |
CMPEN 482W | Computer Engineering Project Design                     | 3       |
CMPSC 473 | Operating Systems Design & Construction                  | 3       |
MATH 220 | Matrices                                                  | 2-3     |
MATH 231 | Calculus of Several Variables                            | 2       |
PHYS 214 | General Physics: Wave Motion and Quantum Physics         | 2       |
STAT/MATH 418 | Introduction to Probability and Stochastic Processes for Engineering | 3       |

Prescribed Courses: Require a grade of C or better

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 110</td>
<td>Chemical Principles I</td>
<td>3</td>
</tr>
<tr>
<td>CMPEN 331</td>
<td>Computer Organization And Design</td>
<td>3</td>
</tr>
<tr>
<td>CMPEN 431</td>
<td>Introduction to Computer Architecture</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 221</td>
<td>Object Oriented Programming with Web-Based Applications</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 311</td>
<td>Introduction to Systems Programming</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 360</td>
<td>Discrete Mathematics for Computer Science</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 465</td>
<td>Data Structures and Algorithms</td>
<td>3</td>
</tr>
<tr>
<td>EE 210</td>
<td>Circuits and Devices</td>
<td>4</td>
</tr>
<tr>
<td>EE 310</td>
<td>Electronic Circuit Design I</td>
<td>4</td>
</tr>
<tr>
<td>EE 353</td>
<td>Signals and Systems: Continuous and Discrete-Time</td>
<td>3</td>
</tr>
</tbody>
</table>
ENGL 202C Effective Writing: Technical Writing 3
MATH 140 Calculus With Analytic Geometry I 4
MATH 141 Calculus with Analytic Geometry II 4
MATH 250 Ordinary Differential Equations 3
PHYS 211 General Physics: Mechanics 4
PHYS 212 General Physics: Electricity and Magnetism 4

Additional Courses
Select 1 credit of First-Year Seminar 1
Select 3 credits of the following: 3
- ECON 14 Principles of Economics
- ECON 102 Introductory Microeconomic Analysis and Policy
- ECON 104 Introductory Macroeconomic Analysis and Policy
Select 6 credits from the following: 6
- CMPEN 411 VLSI Digital Circuits
- CMPEN 416 Digital Integrated Circuits
- CMPEN 417 Digital Design Using Field Programmable Devices
- CMPEN 454 Fundamentals of Computer Vision
- CMPEN 455 An Introduction to Digital Image Processing
- CMPEN 471 Logical Design of Digital Systems
- CMPEN 472 Microprocessors and Embedded Systems
- CMPEN 473 Microcomputer Laboratory
- CMPEN 475 Functional Verification
- EE 453 Fundamentals of Digital Signal Processing
- EE 456 Introduction to Neural Networks
Select 6 credits from any 400-level CMPEN or CMPSC course 6

Additional Courses: Require a grade of C or better
CAS 100A Effective Speech 3
or CAS 100B Effective Speech
or CMPSC 121 Introduction to Programming Techniques 3
or CMPSC 131 Programming and Computation I: Fundamentals
CMPSC 122 Intermediate Programming 1 3
or CMPSC 132 Programming and Computation II: Data Structures
ENGL 15 Rhetoric and Composition 3
or ENGL 30H Honors Rhetoric and Composition
Select 4 credits from the following: 4
- CMPEN 270 Digital Design: Theory and Practice
- CMPEN 271 Introduction to Digital Systems
& CMPEN 275 and Digital Design Laboratory 2

Supporting Courses and Related Areas
Select 6 credits from department list 3 6

1 CMPEN 122 does not require a grade of C or better.
2 CMPEN 275 does not require a grade of C or better.
3 Students may apply up to 3 credits of Co-op. Students who complete ROTC may apply up to 3 credits of ROTC as department list credits and 3 credits of ROTC as GHW credits.

General Education
Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (https://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required.)
- Quantification (GQ): 6 credits
- Writing and Speaking (GWS): 9 credits

Knowledge Domains
- Arts (GA): 6 credits
- Health and Wellness (GHW): 3 credits
- Humanities (GH): 6 credits
- Social and Behavioral Sciences (GS): 6 credits
- Natural Sciences (GN): 9 credits

Integrative Studies (may also complete a Knowledge Domain requirement)
- Inter-Domain or Approved Linked Courses: 6 credits

University Degree Requirements
First Year Engagement
All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement
6 credits are required and may satisfy other requirements
- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum
3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits
A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work
Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition
The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward
degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80)). For more information, check the Suggested Academic Plan for your intended program.

Integrated B.S. in Computer Engineering and M.I.A. in International Affairs

Requirements for the Integrated B.S. in Computer Engineering and M.I.A. in International Affairs can be found in the Graduate Bulletin (https://bulletins.psu.edu/graduate/programs/majors/international-affairs/#integratedundergradgradprogramtext).

Program Educational Objectives

In particular, within a few years after graduation, graduates in computer engineering should be able to:

1. Work in industry or government producing or evaluating components of computer hardware and/or software systems.
2. Work in teams to design, implement, and/or maintain components of computer hardware and/or software systems.
3. Stay current through professional conferences, certificate programs, post-baccalaureate degree programs, or other professional educational activities.

Student Outcomes

Student outcomes describe what students are expected to know and be able to do by the time of graduation. The Computer Engineering program is designed to enable students to:

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.

Academic Advising

The objectives of the university’s academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of-class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee’s unit of enrollment will provide each advisee with a primary academic adviser, the information needed to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (https://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy/)

University Park

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University Park, PA 16802
814-867-4436
anw114@psu.edu

Suggested Academic Plan

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2022-23 academic year. To access previous years’ suggested academic plans, please visit the archive (https://bulletins.psu.edu/undergraduate/archive/) to view the appropriate Undergraduate Bulletin edition (Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin).

Computer Engineering, B.S. at University Park Campus

The course series listed below provides only one of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an Academic Requirements or What If report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.

If you are starting at a campus other than the one this plan is ending at, please refer to: http://advising.engr.psu.edu/degree-requirements/academic-plans-by-major.aspx

First Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 140 (GQ)‡#†</td>
<td>4</td>
<td>CMPSC 121 or 131 (GQ)‡#</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 211 [GN, PHYSICS 211L &amp; PHYSICS 211R]‡#</td>
<td>4</td>
<td>MATH 141 (GQ)‡#†</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 110 (GN)†‡</td>
<td>3</td>
<td>PHYS 212 (GN, PHYSICS 212L &amp; PHYSICS 212R)‡</td>
<td>4</td>
</tr>
<tr>
<td>General Education Course</td>
<td>3</td>
<td>ENGL 15 (GWS)‡</td>
<td>3</td>
</tr>
<tr>
<td>First Year Seminar</td>
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<td>General Education Course</td>
<td>3</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
</tr>
</tbody>
</table>

Second Year

<table>
<thead>
<tr>
<th>Fall</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPEN 270†</td>
<td>3</td>
<td>CMPEN 331†</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 122 or 132‡</td>
<td>3</td>
<td>CMPSC 221†</td>
<td>3</td>
</tr>
<tr>
<td>MATH 250†</td>
<td>3</td>
<td>EE 210†</td>
<td>4</td>
</tr>
<tr>
<td>MATH 220</td>
<td>2-3</td>
<td>MATH 231</td>
<td>2</td>
</tr>
<tr>
<td>PHYS 214</td>
<td>2</td>
<td>ECON 102 or 104 (GS)‡</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course</td>
<td>3</td>
<td><strong>Total</strong></td>
<td><strong>17-18</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
<td><strong>Total</strong></td>
<td><strong>15</strong></td>
</tr>
</tbody>
</table>
## Third Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPEN 431 (^\d)</td>
<td>3</td>
<td>CMPEN 362</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 311 (^\d)</td>
<td>3</td>
<td>CMPSC 465 (^\d)</td>
<td>3</td>
</tr>
<tr>
<td>EE 310 (^\d)</td>
<td>4</td>
<td>CMPSC 473</td>
<td>3</td>
</tr>
<tr>
<td>STAT 418</td>
<td>3</td>
<td>EE 353 (^\d)</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 360 (^\d)</td>
<td>3</td>
<td>ENGL 202C (GWS) (^\d)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total Credits 128-129**

* Course requires a grade of C or better for the major
† Course requires a grade of C or better for General Education
‡ Course is an Entrance to Major requirement
†† Course satisfies General Education and degree requirement

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## Fourth Year

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMPEN 482W (Capstone Design)</td>
<td>3</td>
<td>CMPEN Elective</td>
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</tr>
<tr>
<td>CMPEN Elective</td>
<td>3</td>
<td>CMPSC/CMPEN Elective (^\d)</td>
<td>3</td>
</tr>
<tr>
<td>CAS 100A or 100B (^\d)††</td>
<td>3</td>
<td>CMPSC/CMPEN Elective (^\d)</td>
<td>3</td>
</tr>
<tr>
<td>Department List (General Elective)</td>
<td>3</td>
<td>Department List (General Elective)</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course</td>
<td>3</td>
<td>General Education Course</td>
<td>3</td>
</tr>
<tr>
<td>General Education Course (GHW)</td>
<td>1.5 General Education Course (GHW)</td>
<td>1.5 General Education Course (GHW)</td>
<td>1.5 General Education Course (GHW)</td>
</tr>
</tbody>
</table>

**Total Credits 128-129**

1. This course is the equivalent of the combination of CMPEN 271 and CMPEN 275.
2. EE 353 is only offered in the spring semester.
3. Select from any 400-489 CMPSC or CMPEN course that does not duplicate material already taken or required. No CMPSC/CMPEN 494H or CMPSC/CMPEN 496 may be substituted. CMPSC/CMPEN 497 must be petitioned prior to taking the course.

## University Requirements and General Education Notes:

US and IL are abbreviations used to designate courses that satisfy University Requirements (United States and International Cultures).

W, M, X, and Y are the suffixes at the end of a course number used to designate courses that satisfy University Writing Across the Curriculum requirement.

GWS, GQ, GHW, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GHW, GN, GA, GH, GS, and Integrative Studies). Foundations courses (GWS and GQ) require a grade of ‘C’ or better.

Integrative Studies courses are required for the General Education program. N is the suffix at the end of a course number used to designate an Inter-Domain course and Z is the suffix at the end of a course number used to designate a Linked course.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and replace both ENGL 30H and CAS 100. Each course is 3 credits.

## Career Paths

Computer engineering graduates understand all aspects of computing hardware, are well-studied in the use of modern tools used to design and analyze hardware, are able to think at multiple levels of abstraction when working with system-level design, and have a solid foundation in software development. This background prepares graduates for a wide range of exciting careers in the technology industry and almost all other industry sectors as computer/hardware/embedded system designers. It also prepares them for pursuing academic careers. Computer engineers apply their skills and knowledge to solve challenging problems related to computer hardware. They work collaboratively in teams to design and build complex systems with many integrated parts. They research, study, and develop the new technologies that drive the advances in computing that impact our everyday lives.

## Opportunities for Graduate Studies

Graduates of this program can pursue graduate studies in computer engineering, computer science, and related disciplines, concentrating in specialized areas such as multicore architectures, low-power architectures, application-specific hardware architectures, and computer networking. A master’s degree allows one to specialize beyond the broad foundations offered by a bachelor’s degree. A doctoral degree prepares one for a career in research and academia.

## Professional Resources

- ACM (https://acm.psu.edu)
- Association of Women in Computing (https://awc.cse.psu.edu)
- IEEE (https://sites.psu.edu/psuiee)

## Accreditation

The baccalaureate program in Computer Engineering is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org/.

MORE INFORMATION ABOUT ABET ACCREDITATION (https://www.abet.org/)
Professional Licensure/Certification

Many U.S. states and territories require professional licensure/certification to be employed. If you plan to pursue employment in a licensed profession after completing this program, please visit the Professional Licensure/Certification Disclosures by State (https://psu.edu/state-licensure-disclosures/) interactive map.

Contact

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