COMPUTER ENGINEERING, B.S. (BEHRENDRND)

Begin Campus: Any Penn State Campus
End Campus: Erie

Program Description
This major provides students with a strong foundation in computer engineering through a combination of classroom study, design projects, and laboratory experience. Analysis and design of computer hardware and software systems are stressed. Built upon a core of science and mathematics courses, this major has the objective of educating graduates to be problem solvers. Students acquire the ability to work as members of a team toward successful attainment of a common goal, preparing them for industry or further study in graduate school. In addition, written and oral communication skills are developed from an early stage, culminating in a senior design project that stresses communication as well as engineering content.

In addition to completing a broad-based science core in mathematics, chemistry and physics, students pursue their interest in computer engineering by studying principles in digital hardware design, computer architecture, computer software, microelectronics, and computer data communications. The student will be required to analyze and solve a significant computer engineering design problem during the senior year.

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’ve ever opened a computer housing to explore what’s inside.
• You enjoy working with both hardware and software.
• You’re interested in both engineering and computing—and in the overlap of the two disciplines.
• You’d like to take coursework in computers, engineering, math, and physics.

Entrance to Major
In addition to the Carnegie unit and minimum GPA requirements described by University policies, all students applying for entrance to any of the engineering majors at Behrend College must have at least a 2.0 cumulative GPA by the end of the semester prior to applying for entrance to the major and have completed, with a minimum grade of C: CHEM 110, MATH 140, MATH 141, and PHYS 211. These courses must be completed by the end of the semester during which the admission to major process is carried out.

Degree Requirements
For the Bachelor of Science degree in computer engineering, a minimum of 130 credits is required:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
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<tbody>
<tr>
<td>General Education</td>
<td>45</td>
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<tr>
<td>Electives</td>
<td>1</td>
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<tr>
<td>Requirements for the Major</td>
<td>105</td>
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21 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 GWS courses; 3 credits of GS courses.

Per Senate Policy 83.80.5, the college dean or campus chancellor and program faculty may require up to 24 credits of coursework in the major to be taken at the location or in the college or program where the degree is earned.

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 (http://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). For more information, check the Suggested Academic Plan for your intended program.

**Requirements for the Major**  
Each student must earn at least a grade of C in each 300-and 400-level course in the major field.

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. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

**Prescribed Courses**  
Select 9 credits of technical elective courses from school-approved Prescribed Courses: Operating Systems 3  
CMPEN 441 Operating Systems 3  
CMPEN 461 Communication Networks 3  
CMPEN 480 Computer Engineering Design 3  
CMPEN 481 Computer Engineering Project 3  
CMPSC 122 Intermediate Programming 3  
CMPSC 360 Discrete Mathematics for Computer Science 3  
CMPSC 465 Data Structures and Algorithms 3  
EE 210 Circuits and Devices 4  
EE 310 Electronic Circuit Design I 4  
EE 352 Signals and Systems: Continuous and Discrete-Time 4  
MATH 140 Calculus With Analytic Geometry I 4  
MATH 141 Calculus with Analytic Geometry II 4  
MATH 220 Matrices 3  
MATH 230 Calculus and Vector Analysis 4  
MATH 250 Ordinary Differential Equations 3  
PHYS 211 General Physics: Mechanics 4  
STAT 301 Statistical Analysis I 3

**Additional Courses**  
Select 3 credits of technical elective courses from school-approved Prescribed Courses: Introductory Microeconomic Analysis and Policy 3  
ECON 102 Introductory Microeconomic Analysis and Policy 3  
ECON 104 Introductory Macroeconomic Analysis and Policy 3

**Supporting Courses and Related Areas**  
Select 6 credits from school-approved Prescribed Courses: General Physics: Mechanics 4  
PHYS 211 General Physics: Mechanics 4  
Numerical Analysis 3  
MATH 309

**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.

**Erie**  
Thomas Hemminger, Ph.D.  
Program Chair, Professor  
169 Burke  
Erie, PA 16563  
814-898-6479  
tlh5@psu.edu

**Suggested Academic Plan**  
The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2019-20 academic year. To access previous years’ suggested academic plans, please visit the archive (http://bulletins.psu.edu/undergraduate/archive) to view the appropriate Undergraduate Bulletin edition (Note: the archive only contain suggested
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.

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<tr>
<th>First Year</th>
<th>Credits</th>
<th>Spring</th>
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<td>ENGL 15 or 30††</td>
<td>3 CHEM 111**†</td>
<td>3 CHEM 112*</td>
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<td>MATH 140††</td>
<td>4 MATH 141†††</td>
<td>4 PHYS 211*††</td>
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<td>PHYS 211*††</td>
<td>4 PHYS 212†</td>
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<td>MATH 220††</td>
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<td>2 ENGL 202C††</td>
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<td>ECON 102 or 104††</td>
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<td>CAS 100†‖</td>
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<td>CMPEN 371*</td>
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<td>CMPEN 465*</td>
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<td>EE 310*</td>
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<tr>
<td>CMPEN 441*</td>
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Total Credits 130

* 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

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, GH, GN, GA, GH, and GS are abbreviations used to identify General Education program courses. General Education includes Foundations (GWS and GQ) and Knowledge Domains (GH, 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.

1 Must be completed prior to the junior year to ensure that fall semester junior year prerequisites are met.
2 Course will satisfy Writing Across the Curriculum requirement.

Program Notes:
• Only students who have gone through the entrance to major (ETM) process and have been accepted into this major may register for junior and senior-level EE, CMPEN, and SWENG courses.

School-Approved Electives for Computer Engineering:

Technical electives allow students to choose areas of interest to explore. Technical electives come in two categories: primary and secondary. Primary technical electives are those courses offered to the Computer Engineering major, which are not required for the Computer Engineering degree. Secondary technical electives are offered outside your home department and give you a broader latitude. Students must complete at least two primary technical electives and, at most, one secondary technical elective. Courses listed below as asynchronous are offered as needed when the appropriate faculty member is available.

Exceptions to the above policy will be granted to students who successfully complete a minor in one of the areas listed in the Academic Minors portion of the School of Engineering Advising Handbook.

Primary Technical Electives:
• Any 300-400 level SWENG course
• Any 300-400 level EE course not already required for the major
• Any 300-400 level CMPEN course not already required for the major
• Any 400 level CMPSC course not already required for the major, with the exception of CMPSC 455 and CMPSC 456
• Any 300-400 level technical gaming course

Secondary Technical Electives:
• CMPEN 395 (3:3:0) - Internship - Offered Fall/Spring
• CMPEN 495 (3:3:0) - Internship - Offered Fall/Spring
• CMPSC 461 (3:3:0) - Programming Language Concept - Offered Fall/Spring
• CMPSC 471 (3:3:0) - Introduction to Compiler Construction - Offered Spring
• MGMT 409 (3:3:0) - Project Management for Engineers - Offered Fall/Spring
• PSYCH 444 (3:3:0) - Engineering Psychology - Offered Fall
• ECON 481 (3:3:0) - Business Forecasting Techniques - Offered Fall
• ECON 485 (3:3:0) - Econometric Techniques - Offered Fall
• PHYS 458 (4:3:3) - Intermediate Optics - Offered Every Other Year
• MATH 455 (3:3:0) - Introduction to Numerical Analysis - Offered Fall
• MATH 456 (3:3:0) - Introduction to Numerical Analysis - Offered Spring (Even Years)
• IE 302 (3:3:0) - Engineering Economy - Offered Fall

Career Paths
Breadth of experience with computing technologies makes it possible for computer engineering graduates to begin their careers in nearly every sector of the economy. Entry-level computer engineers typically work in computer design, systems analysis, hardware, software development, signal processing tool design, validation, firmware, and computer vision. Penn State Behrend has a comprehensive support system to help you identify and achieve your goals for college and beyond. Meet with your academic adviser often, and take advantage of the services offered by the Academic and Career Planning Center beginning with your first semester.

Careers

Opportunities for Graduate Studies
Graduate programs in computer engineering often delve more deeply into areas of specialization such as control engineering, automation, embedded sensor systems, hardware and software architecture, biomedical technologies, nanotechnologies, and even economic and financial modeling. Or, you can earn a master's degree to learn management skills; Penn State Behrend offers a Master of Manufacturing Management (M.M.M) degree program for aspiring organizational leaders.

Professional Resources
• ABET (http://www.abet.org)
• Institution of Electrical and Electronics Engineers (IEEE) Computer Society (https://www.computer.org)
• Association for Computing Machinery (https://www.acm.org)
• Society of Women Engineers (http://societyofwomenengineers.swe.org)
• National Society of Black Engineers (http://www.nsbe.org/home.aspx)

Accreditation
The B.S. in Computer Engineering is accredited by the Engineering Accreditation Commission of ABET, abet.org. ABET is a nonprofit, non-governmental accrediting agency for programs in applied and natural science, computing, engineering and engineering technology and recognized as an accreditor by the Council for Higher Education Accreditation. ABET accreditation is voluntary and provides assurance that a college or university program meets the quality standards of the profession for which that program prepares graduates. The School of Engineering at Penn State Behrend consistently places in the Top 50 in U.S. News & World Report's rankings of the nation's undergraduate engineering programs.

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