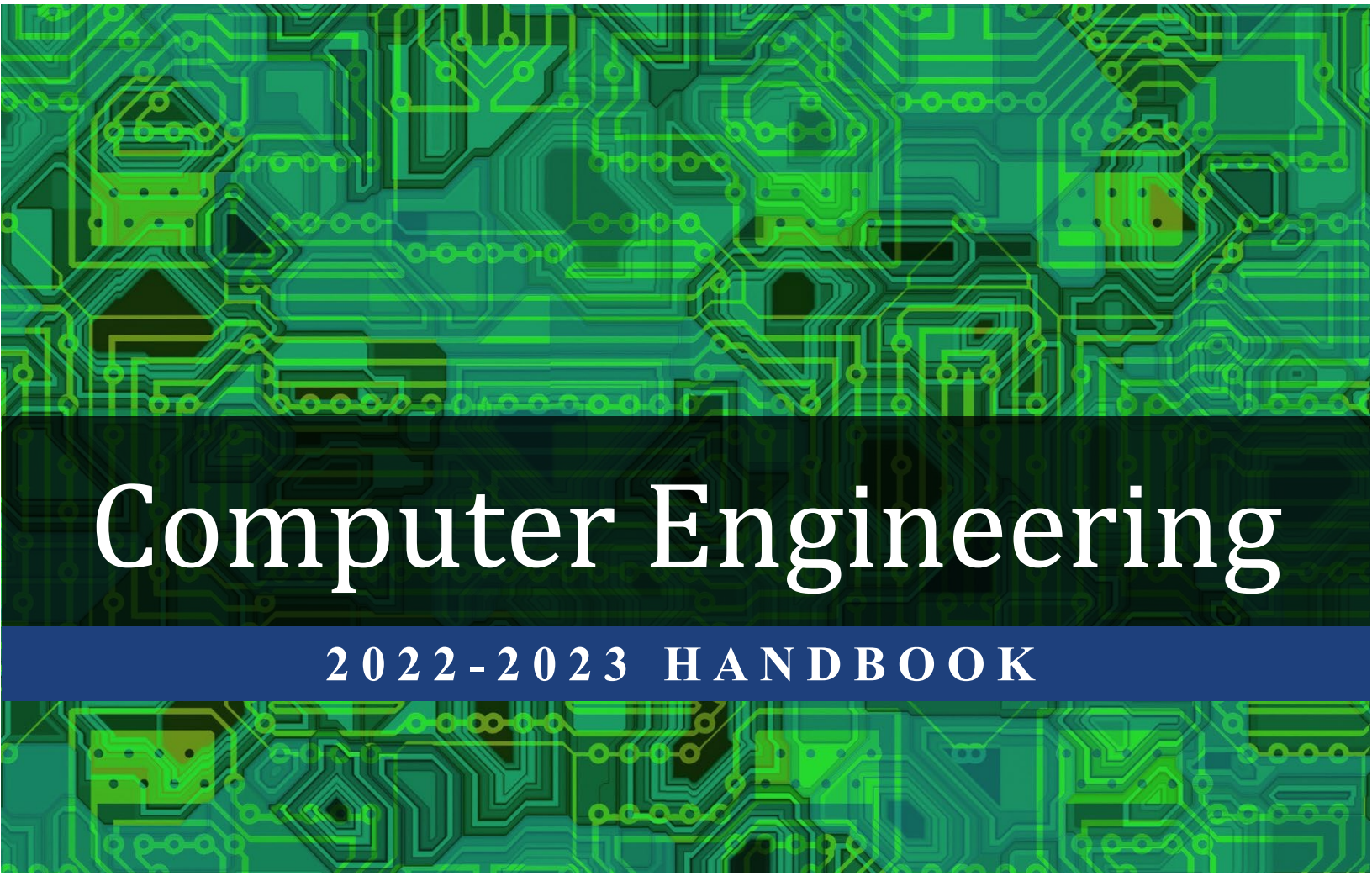

Computer Engineering

2022-2023 HANDBOOK

PennState College of Engineering | ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

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Welcome

This handbook has been prepared for your use as a guide for your studies and as a means of providing you with much of the information that you may need as you continue to work towards your degree. We hope that you read it carefully, and we invite your inquiries about any of the questions or issues that are related to your program. The Academic Affairs staff in W209 Westgate is here to serve you.

Please watch for announcements of special courses, news related to scheduling or textbooks, and other special opportunities delivered via a departmental email list.

Again, welcome to Computer Science and Engineering. We wish you well in your studies and offer our services to assist you.

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The Computer Engineering Major

The Department of Computer Science and Engineering was created in 1993 with the merger of the Computer Engineering Program and the Computer Science Department. The department offers B.S. degrees in both computer engineering (CMPEN) and computer science (CMPSC) through the College of Engineering.

Computer engineering is the discipline concerned with connecting abstract computation to its physical embodiments, and it focuses on the study of four primary areas. The first area includes the design, analysis, and implementation of physically realized systems that perform computational tasks, including the processing, storage, and communication of data. The second area includes the formulation of interfaces and the study of interactions between the hardware portions of these systems and the software running on, communicating with, or managing communications among them, as well as the co-development of software systems alongside their hardware platforms. The third area includes the infrastructure required to design, build, and verify such systems. The fourth area includes the theoretical foundations underpinning the intended and achievable functionality, costs, and performance of both the hardware and software components of these systems and their associated engineering tradeoffs.

Computer engineers provide society with the myriad engines that have powered the information age from the smallest sensor motes to the fastest supercomputers and largest data centers, and with the tools and expertise to use the current generation of computers to design the next. With the ubiquitous integration of mobile communications and computational elements in everything from appliances to cars to clothing to the electrical grid, computer engineers are responsible for developing systems and devices that have transformed the capabilities of both individuals and entire economies.

The mission of the undergraduate program in Computer Engineering is to provide our students with the skills and experience necessary to engage in further study at the graduate level or to pursue any of a broad range of careers as platform integrators, hardware architects, systems programmers, embedded systems designers, network architects, and other positions relating to the design and analysis of computational and other digital hardware and hardware/software systems. The program covers, in both breadth and depth, the representation, communication, and manipulation of information utilizing finite, physical resources from both hardware and software perspectives. It includes coverage of both the fundamental science and the abstract concepts necessary to understand and evaluate the engineering tradeoffs among key performance and cost metrics in the design of hardware and hardware/software systems, including decisions relating to both partitioning and co-design of solutions spanning both hardware and software. The program is structured to ensure that graduates have a clear understanding of the design and the applications of current and historical computer systems and prepares them to be leaders in the rapidly changing field of computing throughout their careers.

Because of the close relationship to computer engineering, concurrent majors in computer engineering and computer science or computer engineering and computational data sciences are not permitted.

Program Objectives

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.

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.

During the first two years, students in computer engineering take many courses in common with other engineering majors, including courses in mathematics, physics, and chemistry. In addition, students take several specialized courses in the major, such as algorithms and programming, electrical engineering, digital systems and logic, and computational theory. From these courses, students gain experience using sophisticated software tools, working in a hardware laboratory, and completing individual and group projects. During the second two years, students complete a series of courses in both hardware and software systems. Students also select from numerous electives. Throughout the four years, students develop communication skills, including a senior year course in which students examine the complete design process and participate in a series of oral and written experiences similar to those that would be seen in industry.

Student Outcomes

The following Student Outcomes summarize the skills acquired through the computer engineering program:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
    a. Design the electronic/logic circuits that form the basic building blocks of a computer system.
    b. Design the architecture and organization of the basic components of a computer system.
    c. Develop a modest (on the order of a thousand lines of code) software application, using appropriate data structures and algorithms.
    d. Determine communication link efficiencies and queueing efficiencies, and calculate probabilities associated with link and system characteristics.

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
    a. Given specifications, design and implement a computer and/or digital system (defined as any digital device used for computation or control) under time and budget constraint.
    b. Identify and address any public health, safety, and welfare concerns in the design of a solution to an engineering problem. (CMPEN 482)
    c. Identify and address any global, cultural, social, environmental, and economic factors in the design of a solution to an engineering problem.
    d. Design components of communication and/or network systems with consideration of the impact of health, safety and welfare - power plants/grid, hospital networks, highway control systems, remote monitoring of public areas, etc.
3. An ability to communicate effectively with a range of audiences
    a. Write clear and effective technical prose for a general audience.
    b. Write clear and effective technical prose for a technical audience
    c. Speak clearly and persuasively about technical subjects in large and/or small group settings, and use supporting materials effectively.
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
    a. Identify ethical issues in engineering case studies.
    b. Be able to discuss major trends in industry and current research activities within the discipline, identifying global, economic, environment and societal impact
    c. Identify ethical and professional responsibilities in project design phase and explain all considerations and alternatives that led to final design decisions
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
    a. Demonstrate an ability to work effectively on team-based projects in which the entire team collaboratively works on designing a solution to meet specified project objectives
    b. Demonstrate an ability to work effectively on team-based projects in which each team member takes responsibility (leadership) for a component of the project and ensures all team members participate and engage in its integration
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
    a. Analyze circuits, devices, and systems using differential and integral calculus and principles of electricity, magnetism, and physics.
    b. Analyze linear systems using continuous and discrete-time techniques.
    c. Analyze the performance of software and/or hardware systems using probabilistic and statistical methods.
    d. Design and simulate computer hardware components using standard tools.
    e. Test circuits, devices, and systems using software, hardware and statistical tools.
    f. Test algorithms or computer code and analyze their correctness and efficiency.

g. Design test cases for testing hardware or software.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.
    a. Demonstrate independent learning by using unfamiliar computer systems, test equipment, and software tools to solve technical problems.
    b. Research the current state of the art in a project domain before designing a solution to the project problem

Students who are interested in math and science and enjoy solving problems are excellent candidates for the computer engineering major. CMPEN 270 and CMPSC 121 or CMPSC 131 are excellent introductions to this major. Job opportunities are virtually limitless; graduates are employed by all sectors of industry, government, and academic institutions. Because of the close relation to computer science, concurrent majors in computer engineering and computer science are not permitted.

Computer Engineering is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410-347-7700 or http://*www.abet.org*.

Advising and Procedures for Major

If you are a student at University Park who is intending to major in computer engineering but who has not yet officially entered the major, you can make an appointment through Starfish to meet with an adviser at the **Engineering Advising Center** (EAC), 208 Hammond Building, 814-863-1033.

If you are a student who has officially entered the computer engineering major, you can find your assigned adviser's name and email address in LionPATH. **If you communicate via e-mail, always use your Penn State account**, not another account such as Gmail. For non-advising issues (questions about e-petition status, course controls, etc.) see one of the CSE staff in W209 Westgate during regular business hours.

Information about all majors at Penn State is listed in the *Undergraduate Bulletin* at https://bulletins.psu.edu/undergraduate/. The *Bulletin* is updated yearly, so make sure to refer to the version of the Bulletin for the semester that you began at Penn State. Clarifications to the Bulletin are noted in this handbook, so it should be used in conjunction with the Bulletin.

The final responsibility for selecting courses and meeting degree requirements is yours. The role of your adviser is to suggest, recommend, and remind you of the requirements of the major and rules of the University.

Do not rely on LionPATH to correctly categorize your courses. LionPATH only understands the degree requirements as specified in the Bulletin and will therefore occasionally place courses into an inappropriate category. This handbook contains additional restrictions and explanations. To ensure that you meet degree requirements, you must have your degree audit reviewed by your

advisor periodically. You should submit petitions to correct any mis-categorization by LionPATH. Failure to do so may result in delaying your graduation until degree requirements are met.

Because computer engineering is such a rapidly changing field, adjustments in course content and/or course offerings should be expected. It will be to your advantage to keep abreast of new course offerings, current course enhancements, and allowable course substitutions through regular contact with your adviser and the department office.

Entrance to the major (ETM), Concurrent majors, Change of major

For the entrance-to-major requirements, see the "How to Get in" section of the Computer Engineering major page in the University Bulletin for the year that you began at Penn State: https://bulletins.psu.edu/undergraduate/archive/

Due to over enrollment, the computer science and computer engineering majors are controlled majors. This means for entrance to the major you must successfully complete the required ETM courses **AND** you must have the needed minimum cumulative GPA for your ETM year when you are in the ETM credit window specified in the Bulletin. Because of this, the CSE Department will not approve requests for transfers from other colleges and universities, requests for change of major after a student has been admitted to a major, requests for computer engineering or science as a second (or later) concurrent major, nor for either major as a sequential major.

Because of the close relationship to computer engineering, concurrent majors in computer engineering and computer science or computer engineering and computational data sciences are not permitted. It is possible to obtain a concurrent major with another non-enrollment-controlled program.

Degree Audits

Instructions on how to run a degree audit are available at https://tutorials.lionpath.psu.edu/public/S_RunningDegreeAudit/. You are responsible for periodically checking your degree audit on LionPATH to verify that the courses you have taken and plan to take will satisfy your degree requirements and that you are on track to complete your degree when you expect to complete it. You are encouraged to meet with an advisor to review your degree audit to verify this information. **Do not rely on LionPATH to place your courses into their appropriate categories.** Do not use a what-if report to check your degree requirements once you are in your major – what-if reports are for students who have not entered their major yet and may not show the correct set of requirements for students who have entered their major.

Registration and Suggested Academic Plan

At least several weeks before it is time to register for the next semester's courses, refer to this handbook and consult with your adviser to determine an appropriate set of courses. It is very important to schedule on your assigned scheduling date– **courses fill up quickly, and if you delay for even a few days, you may not be able to get into recommended courses for the next semester**!

For a copy of the suggested academic plan for the major, refer to the Computer Engineering major page in the University Bulletin for the year that you began at Penn State: https://bulletins.psu.edu/undergraduate/archive/. In addition, a flowchart showing course prerequisites is available at https://advising.engr.psu.edu/degree-requirements/flow-charts.aspx. Keep in mind that the flowchart shows the latest version of the CMPEN requirements – while the flowchart is very helpful for understanding course sequencing, make sure to refer to the Bulletin for the year you began at PSU or your degree audit to confirm the classes you need to take and C-requirements since your requirements may be slightly different than those listed on the flowchart.

Re-ordering your course schedule from the suggested plan will not necessarily delay graduation. The key to completing 128 credits over 4 years is to average approximately 16-17 credits per semester. Though many students do maintain this pace, it is not unusual for students to take lighter loads some semesters and to delay graduation or to take summer classes. Experience has shown that the 5th semester has been difficult for many students; if you have doubts, it is a good place for a light load. Some electives are not offered every semester and most third and fourth year classes are not offered in the summer, so please be careful in your scheduling. **EE 353 is only offered in the spring.**

Please realize that although all the courses listed on the plan in the Bulletin are required for the degree, they need not be taken during the semesters shown in the charts. You may enroll in courses earlier than the semester that they are listed on the academic plan as long as you meet any prerequisites and controls on the courses. Classes that are not a prerequisite to any other courses can usually be taken in a later semester than they are listed on the plan without causing course sequencing issues.

You should be sure to check course prerequisites before you deviate from the suggested schedule. Care should be exercised to be sure core courses are taken in the proper sequence and in a timeframe allowing you to meet entrance to major requirements. You should not wait until your last semester to take C-required courses.

Prerequisite Courses

If a CMPEN or CMPSC course has prerequisites, you must complete the prerequisite course before taking the successor course. For most courses an appropriate grade for prerequisite purposes is a grade of D or higher. If the prerequisite course is a "Prescribed C or better" course and you receive a grade of D, then you may register for the next course but you still must retake the prerequisite course. Waiving of prerequisites is typically only approved in specific circumstances in which the student can show prior learning of the prerequisite content, such as a student having completed a transfer course which was very similar to the listed prerequisite course. Prerequisite override requests are submitted through LionPATH. For instructions about that process, see the document "Requesting a Prerequisite Override" at https://lionpathsupport.psu.edu/student-help/.

Transfer Credit

In addition to taking courses at any Penn State campus, you may be able to earn credit by transferring credits from another school. Before taking a course at another university, use the

transfer credit tool in LionPATH and check with your adviser to be sure the course will transfer usefully.

If you hope to use a transfer course that you have not taken yet to replace a CMPSC or CMPEN course, email a copy of the course syllabus to Prof. Hannan (jjh9@psu.edu) before enrolling in the course to check whether it will be allowed to count for that requirement. If Prof. Hannan approves the use of the transfer credit, you will then need to fill out a petition at https://coursesub.psu.edu/ to have the transfer credit count correctly on your degree audit.

Note that CMPSC 473, CMPEN 431, CMPSC 465 and CMPEN 482W must be taken at Penn State.

Cooperative Education Program and Internships

The cooperative education program provides work experience by alternating periods of academic study and full-time employment in industry or government. The program typically starts at the beginning of the junior year and consists of three rotations, providing a cumulative work experience of one year. Up to 3 credits of co-op may be used for your department list requirement.

If you prefer less of a time commitment, you can pursue one or more summer internships. You earn 1 credit per internship (maximum of 2 credits total) that can be used for your department list requirement.

Instructions for registering for co-op and internship credit can be found at https://career.engr.psu.edu/students/undergraduate/intern-coop/credit-options/courses.aspx. If you are not a formal co-op or internship student, you may still take related summer jobs; however, you may not claim credits for jobs you arrange outside of the formal programs.

Honors Program

Students in the Schreyer Honors College (Atherton Hall, 814-863-2635) may earn honors in computer engineering by completing a thesis with a member of the CSE faculty. See an honors adviser if you are interested in finding out more. (The department office, W209 Westgate Building, can identify the honors advisers for you).

Minors

A minor is a specialization of at least 18 credits that supplements a major. Some courses may concurrently meet the requirements of our major. Popular minors for students in our department include:

1) Engineering Leadership Development
2) Entrepreneurship and Innovation
3) Mathematics
4) Statistics
5) Cybersecurity Computational Foundations

Waivers, Exceptions, and Petitions

In order to graduate from Penn State, all requirements on your degree audit must be marked "satisfied." If you hope to use a course in a way that it does not automatically fill in on your audit, you must submit a petition at https://coursesub.psu.edu/ so that it can be determined whether the substitution you are requesting will be permitted and, if so, your degree audit can be updated. Be sure to submit course substitution petitions prior to taking courses and prior to the semester in which you plan to graduate so that you have time to make adjustments if your petition is not approved.

Note that petitions that require College level approval (exceptions/waivers to College & University requirements, such as general education requirements) must be submitted BEFORE the semester in which you plan to graduate.

Academic Integrity

Recognizing not only the value of integrity in the academic environment, but also its value for the practicing engineer and for society at large, we in the department urge you to act as a responsible professional while you are a student. Academic integrity is defined as follows in Faculty Senate rule 49-20:

> "Academic integrity is the pursuit of scholarly activity free from fraud and deception and is an educational objective of this institution. Academic dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating of information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students."

The EECS School maintains a specific Academic Integrity Statement at
https://www.eecs.psu.edu/students/resources/EECS-CSE-Academic-Integrity.aspx
related to programming courses.

It is commonly accepted that people learn better if they can interact, discuss, and assist each other in solving problems and understanding concepts. Yet persons submitting identical homework papers overstep the bounds of beneficial interaction. The specific limits of acceptable collaboration will be spelled out by the instructor in each course in the course syllabus. The specifics may vary from course to course. Do not, for any reason, show another student a part of your code or write sections of code for another student. Do not put your code online in any location that might be publicly accessible. Any collaboration that exceeds these guidelines or the instructor's guidelines will be considered cheating. Clearly, professionals share ideas, but they should not use another's work without clear acknowledgement of who did the work. Academic dishonesty in any form is not condoned or tolerated.

Engineering Design Experience

Design is incorporated into a majority of the courses taught in the computer engineering program. Many of the courses are split between engineering science and engineering design, so that the design experience is spread throughout the program.

At the sophomore level, in CMPEN 270 or CMPEN 271 and CMPEN 275, students design and build digital circuits consisting of combinational and sequential components. Students begin with analysis type projects, learning basic laboratory skills, problem specification, and project planning. Projects become increasingly more design oriented and open ended, culminating in a significant two- or three-week design effort, allowing the student to make choices and trade-offs between multiple design criteria.

During the junior year, students learn about computer organization and architecture in CMPEN 331 and CMPEN 431. Trade-offs in the design of a computer are examined.

The design experience culminates in the senior year, where students choose from a variety of system-level design courses in both hardware and software areas. Choices include laboratory design courses in microcomputer systems, VLSI, FPGA, software engineering, compilers, databases, and concurrent computing. Each of these courses involves the student in a significant design problem by the end of the course.

The final design course for most students is CMPEN 482W. Students experience the entire design process, starting from problem definition and requirements analysis to proposal preparation, to steps in the design review process, and finally, to design specification and implementation. Projects require students to consider a number of design factors including cost, size, human factors, reliability, power consumption, manufacturability, etc. The course is writing intensive and includes a number of technical writing experiences, as well as oral presentations.

Computer Engineering Topics

Students achieve breadth in computer engineering through a series of required courses. Background in software related areas is gained through CMPSC 121 or 131, CMPSC 122 or 132, CMPSC 221, CMPSC 311, CMPSC 465, and CMPSC 473. Background in hardware areas is gained through CMPEN 270 or CMPEN 271 and CMPEN 275, CMPEN 331, CMPEN 362, and CMPEN 431. It is recommended that after your first semester you take one programming course a semester (CMPSC 121 or 131, 122 or 132, 221, 311, 473) until CMPSC 473 is complete (if possible).

Specialization is provided through the students' selection of senior year electives. Students must select 12 credits of technical electives; see the "Computer Engineering Electives" section of this handbook for more details. **Note that none of CMPSC 494, CMPSC 494H, CMPSC 495, CMPSC 496, CMPEN 494, CMPEN 494H, CMPEN 495, or CMPEN 496 may be used as a technical elective. CMPSC 499 and CMPEN 499 may only be used for technical electives if you are given prior permission via a petition. Some CMPSC 497 or CMPEN 497 courses may be allowed as a technical elective, but a petition requesting this should be filed before taking the course**.

Issues related to the integration of hardware and software, and hardware-software tradeoffs are discussed in the required courses CMPSC 311, CMPEN 331, CMPSC 473, CMPEN 482W, and CMPEN 431, as well as some elective courses such as CMPEN 472 (Microprocessors and Embedded Systems) and CMPEN 473 (Microcomputer Laboratory).

Students receive appropriate introduction to various specialized mathematics topics in a sequence of required courses that include: CMPSC 360 (Discrete Mathematics for Computer

Scientists), STAT 418 (Probability), and MATH 220 (Matrices). A variety of methods for modeling computer processes and systems are introduced in the required courses CMPSC 465, CMPEN 331, CMPSC 473, and CMPEN 431.

Students learn to use a number of computer-aided design tools through the laboratory courses and in regular lecture courses. These include a digital schematic capture and simulation tool in CMPEN 270 or CMPEN 271 and CMPEN 275; an analog simulation tool in EE 210; a hardware design language in CMPEN 331; a hardware description language simulator in CMPEN 431; logic design CAD tools in CMPEN 431 and CMPEN 471; VLSI CAD tools in CMPEN 416; and various digital image processing and computer vision software tools in CMPEN/EE 455 and CMPEN/EE 454.

All students study multiple high-level programming languages such as Python, Java, C, and C++. Students study assembly language in CMPEN 331. Students gain extensive experience in both Microsoft and UNIX operating systems.

GRADUATION REQUIREMENTS

To graduate from the University, every student must:

(1) Complete the course requirements for his or her major (including earning Cs or higher in all C-required courses) and

(2) Earn at least a 2.0 cumulative grade-point average for all courses taken at the University

C-requirements

Some courses for the major require a grade of C or higher to graduate. If you have officially entered your major, the easiest way to see which classes require a grade of C or higher is to check your degree audit. On your degree audit, some sections are labeled as requiring a C or higher, and the classes used toward those sections are the ones that require a grade of C or above. If a class is being used in a section of the degree audit that does not have a label about a C or higher being required, a D or above will fulfill that requirement.

If you have not declared your major yet, you can use the Bulletin to see the classes that are C-required for you. The academic plan, with C-required classes labeled, is available on the Computer Engineering major page in the University Bulletin for the year that you began at Penn State: https://bulletins.psu.edu/undergraduate/archive/.

Computer Science and Engineering (34 credits)

- CMPEN 270 (4) – Introduction to Digital Systems (Concurrent: PHYS 212)
- CMPEN 331 (3) – Computer Organization and Design (CMPEN 271 or CMPEN 270; CMPSC 121 or CMPSC 201)
- CMPEN 362 (3) – Communication Networks (CMPEN 271 or CMPEN 270; Concurrent: STAT 301 or STAT 318 or STAT 401 or STAT 414 or STAT 418)

- CMPEN 431† (3) – Introduction to Computer Architecture (CMPEN 331 or CMPEN 371)
- CMPSC 121 (3) – Introduction to Programming Techniques (MATH 110 or MATH 140 concurrently or as a prerequisite) OR
  CMPSC 131 (3) – Programming and Computation I Fundamentals (MATH 110 or MATH 140 concurrently or as a prerequisite)
- CMPSC 122 (3) – Intermediate Programming (CMPSC 121) OR
  CMPSC 132 (3) - Programming and Computation II Data Structures (CMPSC 121 or CMPSC 131)
- CMPSC 221 (3) – Object Oriented Programming with Web-Based Applications (CMPSC 122 or 132)
- CMPSC 311 (3) – Systems Programming (CMPSC 221)
- CMPSC 360 (3) – Discrete Mathematics for Computer Science (Concurrent: CMPSC 122 or 132)
- CMPSC 465† (3) – Data Structures and Algorithms (CMPSC 360 or MATH 311W)
- CMPSC 473† (3) – Operating Systems (CMPSC 311; CMPEN 331)

†Neither transfer credits nor study abroad credits may substitute.

Computer Engineering Electives (12 credits)

There are two categories of computer engineering electives required for the CMPEN major:

1. Select 6 credits from the following list (prerequisites appear in parentheses). This requirement is referred to as "computer engineering elective" on the flowchart and "CMPEN elective" in the Bulletin.

- CMPEN 416 (3) – Digital Integrated Circuits (EE 310)
- CMPEN 417 (3) – Digital Design using Field Programmable Devices (CMPEN 331)
- CMPEN 454 (3) – Fundamentals of Computer Vision (MATH 230 or MATH 231; CMPSC 121 or CMPSC 201)
- CMPEN 455 (3) – Digital Image Processing (EE 353 or EE 350; CMPSC 121 or CMPSC 201)
- CMPEN 462 (3) Wireless Communication Systems and Security (CMPEN/EE 362)
- CMPEN 471 (3) – Logical Design of Digital Systems (CMPEN 331)
- CMPEN 472 (3) – Microprocessors and Embedded Systems (CMPEN 331)
- CMPEN 473 (3) – Microcomputer Laboratory (CMPEN 472)
- CMPEN 475 (3) – Functional Verification (CMPEN 331)

- EE 453 (3) – Fundamentals of Digital Signal Processing (EE 351 or EE 351 or EE 353)
- EE 456 (3) – Introduction to Neural Networks (CMPSC 201; MATH 220)

2. Select 6 credits from any 400-level CMPSC or CMPEN course, **excluding 494, 495, 496, 497, 499 and courses offered at non-UP locations which cover duplicate material (unless prior approval has been given for you to use a CMPSC or CMPEN 497 or 499 course)**. This requirement is referred to as "CMPEN/CMPSC 4XX" on the flowchart and "CMPSC/CMPEN elective" in the Bulletin.

Some courses are NOT offered every semester or even every year.

Writing Intensive Course (3 credits)

- CMPEN 482W (3) – Computer Engineering Project Design (CMPSC 311, EE 310, EE 353 prerequisite; CMPSC 473 prerequisite or concurrent))

Electrical Engineering (11 credits)

- EE 210 (4) – Circuits and Devices (PHYS 212; concurrent: MATH 250)
- EE 310 (4) – Introduction to Electron Devices and Circuits (EE 210)
- EE 353 (3) – Signals and Systems: Continuous and Discrete-Time (EE 210 and (MATH 250 or MATH 251)

EE 353 is only offered in spring semesters

Communications (9 credits)

- ENGL 15 GWS (3) – Rhetoric and Composition (ENGL 30 or ESL 15 may be substituted)
- ENGL 202C GWS (3) – Technical Writing
- CAS 100 A/B (3) – Effective Speech

ENGL/CAS 137 & 138 may substitute for ENGL 15 and CAS 100 A/B

Quantification and Statistics (18 credits)

- MATH 140 GQ (4) – Calculus with Analytic Geometry I
- MATH 141 GQ (4) – Calculus with Analytic Geometry II
- MATH 220 GQ (2) – Matrices
- MATH 231 (2) – Calculus of Several Variables
- MATH 250 (3) – Ordinary Differential Equations
- STAT (MATH) 418 (3) – Probability

Natural Sciences (13 credits)

- CHEM 110 GN (3) – Chemical Principles
- PHYS 211 GN (4) – General Physics (mechanics)
- PHYS 212 GN (4) – General Physics (electricity, magnetism)
- PHYS 214 GN (2) – General Physics (wave motion and quantum physics)

Other General Education (21 credits)

The Health and Wellness (GHW) requirement can be met by taking one 3-credit course or various credit combinations, most frequently two 1.5 credit courses (which can be taken in different semesters). A student who completes an ROTC program may use 3 credits of ROTC to satisfy the GHW requirement.

Details for the remaining General Education requirements can be found in the Baccalaureate Degree General Education Requirements at https://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/.

Department List (General Elective) Guidelines (6 credits)

Choose enough credits to bring the total number of credits up to at least 128. We encourage, but do not require, the taking of technical electives in Computer Science, Engineering, Math or Physics in this category. If your US/IL course was not an Arts, Humanities, or Social or Behavioral Sciences course, it may be counted in this list. These are sometimes called approved free electives or general electives and most classes at Penn State will qualify as department list, but the following restrictions apply:

The following restrictions apply:

- No courses not satisfying minimum requirements for a baccalaureate degree program (see course descriptions in University Bulletin)
- No courses described as intended for non-science or non-technical majors in the course descriptions in the University Bulletin (**You may take non-technical courses**, but look at the Bulletin to be sure the description doesn't say "for non-science majors only").
- No courses similar or remedial to a required course or course already taken (when in doubt, check with your advisor before scheduling the course). For example, you may not include 2 credits of MATH 140A or 2 credits of CHEM 106.
- No more than 3 additional credits of physical education
- No more than 3 credits of Cooperative Education
- No more than 2 credits of Engineering Internship
- None of the following:
    - Astronomy (ASTRO) 1, 6, 7N, 10, 11, 120, 140
    - Biological Science (BISC) 1, 2, 3, 4
    - Chemistry (CHEM) 1, 3, 108, 101
    - Computer Science (CMPSC) 100, 101, 200, 201, 203
    - Cybersecurity Analytics and Operations (CYBER) 100
    - Earth and Mineral Sciences (EMSC) 150
    - English as a Second Language (ESL) 4
    - Information Science & Technology (IST) 140, 210, 220, 230, 240, 242, 261, 311, 361
    - Language and Literacy Education (LLED) 5, 10
    - Mathematics (MATH) 200, 201, MATH below 140
    - Philosophy (PHIL) 12
    - Physical Science (PHSC) 7
    - Physics (PHYS) 250, 251, PHYS below 211

- Science, Technology, and Society (STS) 150
- Speech Communication (CAS) 126, 283
- Statistics (STAT) below 319 except for STAT 200
- Statistics (STAT) 401, 487
- STAT (MATH) 318, STAT (MATH) 414

Because most classes at Penn State (that you are not already using for another degree requirement) can count toward department list, there isn't a list of all classes that can be used – it would be very long. Rather, refer to the list above of types of courses that are not eligible for this requirement.

First Year Seminar (1 credit)

Most CMPEN majors take a 1-credit first-year seminar in either their first or second semester at Penn State. If you did not take a first-year seminar that was a separate 1-credit course, you must make up the first-year seminar credit by taking an extra credit of coursework that is acceptable for the department list requirement. Then, submit a petition at https://coursesub.psu.edu/ requesting to use the extra credit of department list coursework to fulfill the first-year seminar requirement on your degree audit.

Sources of Information

This *Handbook* provides program information specifically for the undergraduate computer engineering major. It should be used as a supplement to the *College of Engineering Undergraduate Programs Guide* that is available online. The information in this *Handbook* pertains to students who began at Penn State in Summer 2022, Fall 2022, or Spring 2023 semesters. Students who began at Penn State in an earlier year should refer to the appropriate earlier version of the Handbook. Students in pre-major (ENGR) status may use this Handbook as a reference for scheduling; however, your official degree requirements will be established when you enter the major.

Although this *Handbook* lists all requirements for the computer engineering major, only those specific to computer engineering are described in detail. Other general College and University requirements are discussed only briefly with references to more comprehensive supporting documents. Hard copies of these documents can be obtained from a Dean's office or local bookstore. Many are available on-line. A list of useful web resources is provided below. For easy reference, resource names are printed in bold throughout the *Handbook*.

School of EECS – http://eecs.psu.edu
Engineering Advising Center – https://advising.engr.psu.edu
Academic Advising Portal – http://advising.psu.edu
Bulletin of Baccalaureate Degree Programs – http://bulletins.psu.edu/undergrad
University Faculty Senate – http://www.senate.psu.edu/policies/
Student Affairs – https://studentaffairs.psu.edu
General Education – https://gened.psu.edu
LionPATH – http://launch.LionPATH.psu.edu
Association of Women in Computing - http://www.awc.cse.psu.edu
Association for Computing Machinery Student Chapter – http://acm.psu.edu