COMPUTER SCIENCE, B.S. (CAPITAL)

Begin Campus: Any Penn State Campus
End Campus: Harrisburg

Program Description
This program is designed to prepare students for employment as computer scientists in engineering, scientific, industrial, and business environments as software developers, programmers, and systems analysts. While most students will enter the job market directly upon graduation, graduate school in computer science or related areas is also an option. Selection of electives can be tailored for students pursuing this path.

The Computer Science major provides a solid foundation in the areas of systems programming, algorithm design, artificial intelligence, and engineering large software systems using state-of-the-art methodologies and programming languages.

Students may expect to: develop a solid foundation in mathematical studies relevant to computer science; master skills in computer science; enjoy possibilities for internships and part-time employment with local companies; and become problem solvers. These goals are consistent with the goals outlined by the Association of Computing Machinery.

What is Computer Science?
Computer science is the study of computational methods, including their principles and foundations, their efficient implementation, their analyses, and their practical application in wide-ranging areas. It includes the foundations of software development, computational problem solving, the principles of system software, and the fundamental principles and limits of computing. It is much more than just programming. It includes the mathematical foundations that support analyzing, evaluating, and proving the correctness of computational solutions. It includes specializations such as artificial intelligence, machine learning, cybersecurity, data mining, high-performance computing, computer networks, computer graphics, computer vision, quantum computing, and others. It is continually evolving with the development of new and faster forms of computation and with the identification of new problems that require computational solutions.

You Might Like This Program If...
- You have an interest or aptitude in math.
- You enjoy solving problems and you are good at analytical thinking.
- You are interested in finding more efficient solutions to problems.
  Remember, computer science is more than just programming.

Entrance to Major
Entry to the Computer Science major requires that the student has earned a C or better in the following courses: MATH 140, MATH 141, CMPSC 121, and CMPSC 122.

A 2.00 or higher cumulative grade-point average is required.

Degree Requirements
For the Bachelor of Science degree in Computer Science, a minimum of 120 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>Requirements for the Major</td>
<td>88</td>
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</tbody>
</table>

13 of the 45 credits for General Education are included in Requirements for the Major. This includes: 3 credits of GWS courses, 6 credits of GQ courses, and 4 credits in GN courses.

FIRST-YEAR SEMINAR: Incoming first-year students are required to complete a course with the suffix S, T, or X, or the PSU abbreviation.

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 (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.

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).

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<tr>
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</tr>
<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
</tr>
</tbody>
</table>

Additional Courses
Select one of the following:
- MATH 318: Elementary Probability
- STAT 301: Statistical Analysis I
- STAT 318: Elementary Probability

Select 15 credits of the following (9 of which must have a CMPSC prefix):
- CMPSC 313: Assembly Language Programming
- CMPSC 412: Data Structures Lab
- CMPSC 413: Algorithms Lab
- CMPSC 426: Object-oriented Design
- CMPSC 438: Computer Network Architecture and Programming
- CMPSC 441: Artificial Intelligence
- CMPSC 444: Secure Programming
- CMPSC 455: Introduction to Numerical Analysis I
- CMPSC 457: Computer Graphics Algorithms
- CMPSC 475: Applications Programming
- CMPSC 496: Independent Studies
- CMPSC 497: Special Topics
- MATH 401: Introduction to Analysis I
- MATH 411: Ordinary Differential Equations
- MATH 412: Fourier Series and Partial Differential Equations
- MATH 425: Introduction to Operations Research
- MATH 430: Linear Algebra and Discrete Models I
- MATH 431
- MATH 435: Basic Abstract Algebra
- MATH 449: Applied Ordinary Differential Equations
- MATH 450: Mathematical Modeling
- MATH 455: Introduction to Numerical Analysis I
- MATH 465: Number Theory
- MATH 468: Mathematical Coding Theory
- MATH 496: Independent Studies
- MATH 497: Special Topics

Supporting Courses and Related Areas
Select 6 credits of 300-400 level courses in consultation with an academic adviser and in support of the student’s interests
Select 5 credits of 100-400 level courses

1 Requires a grade point average of 2.5 or higher.

Integrated B.S./M.S. Program in Computer Science
The Computer Science program offers a limited number of academically superior Bachelor of Science candidates the opportunity to enroll in an integrated, continuous program of study leading to both the Bachelor of Science and the Master of Science in Computer Science. The ability to coordinate as well as concurrently pursue the two degree programs enables the student to earn the two degrees in five years.

Students in the IUG program must satisfy the degree requirements for both Bachelor of Science and Master of Science degrees. However, the total course load is reduced due to the maximum of 12 credits that can
count towards both degrees. A minimum of 6 credits proposed to count for both degrees must be at the 500 level. Thesis credits may not be double counted. The first two years of the IUG program are identical to the first two years of the Bachelor of Science program. The third and fourth years of the IUG program differ from those of the Bachelor of Science program due to the courses that count toward the Master of Science degree requirements. Student performance will be monitored on an on-going basis. In addition, a formal evaluation of student academic performance will be performed when the student has completed 100 to 105 credits, which is at the end of the first semester of the senior year for a typical student in the program.

Students who have not maintained a 3.5 GPA in their Math and Computer Science courses will be put on probationary status with respect to the IUG program. Their ability to continue in the IUG program will be based on their academic performance in the last semester of their senior year. As part of the review in the senior year, students will be advised about the paper option and thesis option in the graduate program. Students intending to pursue the thesis option would be advised to do so only if they have been doing very well in the program and are in no danger of not being able to continue into the fifth year. A minimum grade point average of 3.5 must be earned in all math and computer science course work that is applied toward the graduate degree. This includes any courses that count toward both the undergraduate and graduate degrees, as well as all courses taken during the fifth year.

Students have the choice of receiving the B.S. degree at the end of the fourth year or waiting until the end of the fifth year to receive both degrees. Students who elect to receive the B.S. degree at the end of the fourth year will pay graduate tuition for courses taken in the fifth year; students opting to receive both degrees at the end of the fifth year will pay undergraduate tuition for all five years. Note that students who are awarded a graduate assistantship must elect to receive the B.S. degree at the end of the fourth year. If for any reason a student admitted to the IUG program is unable to complete the requirements for the Master of Science degree, the student will be permitted to receive the Bachelor of Science degree assuming all the undergraduate degree requirements have been satisfactorily completed. Students who successfully complete the courses listed in the recommended schedule will satisfy the requirements for the Bachelor of Science degree by the end of their fourth year.

Admission Requirements
To initiate the application process, students must submit an Integrated Undergraduate-Graduate (IUG) Degree in Computer Science Application Form, a transcript, and a faculty recommendation, in addition to applying for admission to the Graduate School. A faculty adviser will help undergraduate candidates determine a sequence of courses that will prepare them for acceptance into the Integrated Undergraduate-Graduate (IUG) degree program. In order to apply for the IUG program, students must have completed a minimum of 45 credits. A typical student would apply after completing between 45 to 60 credits, that is, after the fourth semester and before the end of the fifth semester. For consideration for acceptance into the program, students must have completed and earned a minimum grade point average of 3.0 in the following Computer Science and Mathematics courses:

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<tr>
<td>MATH 220</td>
<td>Matrices</td>
<td>2-3</td>
</tr>
<tr>
<td>CMPSC 121</td>
<td>Introduction to Programming Techniques</td>
<td>3</td>
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</table>

Student applications will be evaluated based on their overall academic performance, in addition to the above requirements. In all cases, admission to the program will be at the discretion of the Graduate Admissions Committee in Computer Science.

Degree Requirements
Students in the IUG program must satisfy the degree requirements for both Bachelor of Science and Master of Science degrees. The total course load is reduced due to the maximum of 12 credits that can count towards both degrees. The minimum of 6 credits double-counted must be at the 500 level. Thesis credits may not be double counted.

Program Learning Objectives
1. **Know Programming Language Paradigms**: Demonstrate proficiency by expressing algorithms clearly and correctly in a variety of programming languages.
2. **Know Algorithmic Problem Solving and Analysis**: Formulate and solve problems using appropriate data structures and algorithmic techniques; analyze the efficiency and correctness of the algorithms.
3. **Use Software Engineering Skills**: Demonstrate the ability to design and implement large software systems through a strong foundation in the software development lifecycle, effective communication, and teamwork.
4. **Know Computer Hardware and Operating Systems**: Analyze the effects of computer hardware and operating systems design on the efficiency and correctness of software systems.
5. **Know Theoretical Foundations of Computer Science**: Demonstrate an understanding of the theoretical foundations of computer science and explain and use them effectively.

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 (http://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy)

Harrisburg
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Program Chair
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717-948-6088
flv@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 academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin).

Harrisburg Campus

Computer Science

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 time. This plan should be used in conjunction with your degree audit.

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<td>CAS 100†</td>
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<td>MATH 140‡</td>
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<td>CMPSC 312*</td>
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<td>CMPSC 430</td>
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<td>STAT 301, MATH 318, or STAT 318</td>
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<td>CMPSC 462</td>
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<td>CMPSC 360</td>
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<td>CMPSC 472</td>
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| CMPSC 487W | 3 | CMPSC 488 | 3 |
| Additional Computer Science/Math Course | 6 | Additional Computer Science/Math Course | 3 |
| Supporting Course, 100-400 level course in consultation with adviser | 2-3 |
| | | | |
| Total Credits 120-123 |

* 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

1. Natural Sciences (GN), recommended courses:
   - PHYS 212 - General Physics: Electricity and Magnetism
   - The following courses are among the specified group of courses for which a cumulative GPA of 2.5 or higher is required:
   - CMPSC 360 - Discrete Mathematics for Computer Science
   - CMPSC 312 - Computer Organization and Architecture
   - CMPSC 221 - Object Oriented Programming with Web-Based Applications
   - CMPSC 462 - Data Structures
   - CMPSC 430 - Database Design
   - CMPSC 453 - Design and Analysis of Algorithms
   - CMPSC 469 - Formal Languages with Applications

2. Technical Elective (Select 3 Credits)
   Courses are among the specified group of courses for which a cumulative GPA of 2.5 or higher is required.
   - CMPSC 470 - Compiler Construction
   - CMPSC 472 - Operating System Concepts
   - CMPSC 487W - Software Engineering and Design

3. Technical Electives (Select 6 Credits)
   Courses are among the specified group of courses for which a cumulative GPA of 2.5 or higher is required.
   - CMPSC 460 - Principles of Programming Languages
   - CMPSC 488 - Computer Science Project

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.

Program Notes:
Technical Electives
Computer Science 2+2

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- Course requires a grade of C or better for the major
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- Course is an Entrance to Major requirement
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## General Education Course (GHW)

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### Third Year

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<th>Fall Credits</th>
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<td>15-16</td>
<td>14.5-15.5</td>
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- CMPSC 312* 3
- STAT 301, MATH 318, or STAT 318 3
- CMPSC 360 3
- Additional Computer Science/Math Course 3
- Supporting Courses, 300-400 level course in consultation with adviser 3

### Fourth Year

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- CMPSC 463 3
- CMPSC 472 3
- CMPSC 487W 3
- Additional Computer Science/Math Course 3
- Supporting Courses, 100-400 level course in consultation with adviser 2-3

### Program Notes

**Technical Electives**

- CMPSC 313 - Assembly Language Programming (3)
- CMPSC 412 - Data Structures Lab (1.5)
- CMPSC 413 - Algorithms Lab (1.5)
- CMPSC 428 - Introductory ADA and Program Design (3)
- CMPSC 438 - Computer Network Architecture and Programming (3)
- CMPSC 441 - Artificial Intelligence (3)
- CMPSC 444 - Secure Programming (3)
- CMPSC 455 - Introduction to Numerical Analysis I (3)
- CMPSC 457 - Computer Graphics Algorithms I (3)
- CMPSC 475 - Applications Programming (3)
- CMPSC 496 - Independent Studies (1-18)
- CMPSC 497 - Special Topics (1-9)

- MATH 465 - Number Theory (3)
- MATH 468 - Mathematical Coding Theory (3)
- MATH 496 - Independent Studies (1-18)
- MATH 497 - Special Topics (1-9)

### Career Paths

Computer Science jobs are expected to be among the top three fastest growing occupations and one of the top 20 in the number of new jobs created. According to the U.S. Bureau of Labor Statistics, employment opportunities for Computer Science graduates are projected to grow 12 percent from 2014 to 2024, faster than the average for all occupations. Computer Science students are encouraged to incorporate internships into their academic program. Internships can provide valuable hands-on experience that will benefit graduates during their job search. Previous students have completed successful internships with state government, IBM, UNISYS, and other businesses.

### Careers

This program is designed to prepare students for employment as computer scientists in engineering, scientific, industrial, and business environments as software developers, programmers, and systems analysts. Over the last few years, Penn State Harrisburg Computer Science graduates have obtained positions with companies such as Blue Cross/Blue Shield, Google, Boeing, Microsoft, Intel, IBM, Oracle, General Dynamics, Northrop and Grumman, GEOS, Hershey Medical Center, Woolworth, Rite Aid, and EDS.

### Opportunities for Graduate Studies

The program provides a sound background for students who plan to pursue graduate studies in computer science, including Penn State’s Master of Science in Computer Science program. Selection of electives can be tailored for students pursuing this path.

MORE INFORMATION ABOUT OPPORTUNITIES FOR GRADUATE STUDIES (https://harrisburg.psu.edu/science-engineering-technology/computer-science-and-mathematics/master-science-computer-science)

### Professional Resources

- Association for Computing Machinery (https://orgsync.com/104244/chapter)

### Contact

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https://harrisburg.psu.edu/science-engineering-technology/computer-science-and-mathematics/bachelor-science-computer-science

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