



Computer Science Undergraduate Handbook

Department of Computer Science and Engineering

Fall 2015

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Helpful University Park Offices and Phone Numbers

College of Engineering:	
Dean's Office, 101 Hammond Building	865-7537
Associate Dean Academic Programs, 101 Hammond Building	863-3750
Global Engineering Education, 205 Hammond Building	863-9899
Engineering Advising Center, 208 Hammond Building	863-1033
Assistant Dean for Student Services, 208G Hammond Building	865-7539
Multicultural Engineering Program, 208 Hammond Building	865-7138
Women in Engineering Program, 208 Hammond Building	863-1080
Engineering Career Resources and Employer Relations, 205 Hammond Building	863-1032
Outreach for Adult Learners, 128 Outreach Building	863-2504
Career Services, 101 MBNA Career Services Center	865-2377
Information Technology Services (ITS) Help Desk, 204 Wagner Building	865-4357
Counseling and Psychological Services (CAPS), 501 Student Health Center	863-0395
Office for Disability Services, 116 Boucke Building	863-1807
Penn State World Campus, 128 Outreach Building	865-5403
Division of Undergraduate Studies (DUS), 101 Grange Building	865-7576
Penn State Learning, 220 Boucke Building	865-1841
Office of Student Aid, 314 Shields Building	865-6301
Residence Life, 201 Johnston Commons	863-1710
Undergraduate Admissions (for transferring credits), 201 Shields Building	865-5471
Schreyer Honors College, 10 Schreyer Honors College (Atherton Hall)	863-2635
Office of Veterans Programs, 325 Boucke Building	863-0465
General Information, HUB Desk, First Floor Lobby	865-2000

Sources of Information

This *Handbook* provides program information specifically for the undergraduate computer science 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 entered or will be entering the major in summer 2015, fall 2015, or spring 2016 (2015 program year). Students entering the major 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. For information about the computer engineering degree, refer to the *Computer Engineering Undergraduate Handbook*. All of these documents are available in the department office, 342G Information Sciences and Technology Building and online at www.cse.psu.edu/current/ugrad. (If you are at a campus other than University Park, you should contact the College of Engineering representative at your location).

Although this *Handbook* lists all requirements for the computer science major, only those specific to computer science 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*.

Registrar's Schedule of Courses – http://schedule.psu.edu
Academic Advising Portal – http://advising.psu.edu
Department of Computer Science & Engineering – http://www.cse.psu.edu
Penn State University – http://www.psu.edu
Engineering Advising Center – http://www.engr.psu.edu/Advising/
Bulletin of Baccalaureate Degree Programs – http://bulletins.psu.edu/undergrad
University Faculty Senate Policies and Rules for Undergraduate Students – http://www.senate.psu.edu/policies/
Student Guide to General University Policies and Rules – http://studentaffairs.psu.edu/conduct/docs/PoliciesRules.doc
General Education and US & International Cultures in the Curriculum – http://bulletins.psu.edu/undergrad/generaleducation/
eLion – https://elion.psu.edu/
Association of Women in Computing - http://www.clubs.psu.edu/up/awc/
Association for Computing Machinery Student Chapter – http://acm.psu.edu

For additional information, you can contact the **Engineering Advising Center** (208 Hammond, 863-1033), the Assistant Dean for Student Services (208 Hammond, 865-7539), or the **Department of Computer Science and Engineering** (342G Information Sciences and Technology Building, 865-9505). The structure in the Department of Computer Science and Engineering includes an Undergraduate Program Coordinator, an Undergraduate Adviser and an Undergraduate Staff Assistant, all of whom can provide information and guidance during your academic career. **If you communicate via e-mail, always use your Penn State account**, not another account such as g-mail.

The Computer Science 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 science (CMPSC) and computer engineering (CMPEN) through the College of Engineering.

The computer science undergraduate major at Penn State has two phases. The first phase introduces the concepts of modern computer science, including structured programming languages and efficient, productive programming. The second phase examines data structures, programming languages, and computer systems in detail. Course work involves writing computer applications and polishing programming skills.

The baccalaureate program in computer science provides a fundamental education to prepare students for positions in industry, government, education, or commerce, or to pursue graduate study. The computer science curriculum is organized with two goals in mind. First, upon graduation a student must be prepared to meet immediate demands in solving computational problems. Second, a student must have sufficient understanding of basic principles and concepts in computer science to avoid technological obsolescence in the rapidly changing information technology environment.

This program is intended to produce computer science professionals and not merely technicians with some training in computer programming. Success requires a strong aptitude in mathematics. Because of the close relationship to computer science, concurrent majors in computer engineering and computer science are not permitted.

Advising and Procedures for Major

If you are a first- or second-year student at University Park who is intending to major in computer science, you will see an adviser at the **Engineering Advising Center (EAC)**, 208 Hammond Building, 863-1033. This office is open Monday through Friday, 8:00 a.m. to 5:00 p.m. (Walk-in advising is available but appointments are encouraged).

If you are a junior or senior who has been admitted into the computer science major you will see the Department of Computer Science and Engineering Undergraduate Adviser. The email address, advising@cse.psu.edu will send email to the Undergraduate Adviser. Schreyer Scholars will be assigned a Scholar's Adviser.

Required courses for the computer science major and a suggested schedule are given on the following pages. Information about all majors at Penn State are listed in the **Bulletin of Baccalaureate Degree Programs**. The *Bulletin* is updated yearly and should be used along with this Handbook. Clarifications to the *Bulletin* are noted here.

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. (Two helpful references for University procedures on-line are: **University Faculty Senate Policies for Students** and the **Student Guide to General University Policies and Rules**. When meeting with your adviser, always take a copy of your recent audits, transcript, your present schedule, and your plan for at least the next semester's courses.

Because computer science 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) – To qualify for the computer science major:

- (1) You must complete MATH 140, MATH 141, MATH 230, PHYS 211, PHYS 212, and CMPSC 122 with a grade of C or better in each and have at least a 2.6 cumulative GPA in order to be admitted to the computer science major. You may request admission to the major via eLion as soon as you have completed 40 credits of **Penn State coursework** and before you complete 59 credits of Penn State coursework. **Note that, unlike other engineering majors, computer science requires CMPSC 122, not CHEM 110, and MATH 230, not MATH 250/251 for determining entrance to the major.**
- (2) You should complete at least two full semesters of coursework appropriate to the major and be in degree status. It is advisable to be taking CMPSC 221 and CMPEN 271 during your second year in order to make normal progress. Be sure you're accumulating credits at a minimum rate of 30 credits per calendar year.

Enrollment Controls – Due to over enrollment, the computer engineering and computer science 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 of 2.6. 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.

Change of Major – If you discover an interest in other areas of study or you are not admitted into computer science, you should explore other possible majors and alternatives at the **Engineering Advising Center** or at online at the **Academic Advising Portal**.

Concurrent Major – Concurrent majors will not be allowed in computer science and computer engineering, although it is possible to obtain a concurrent major with another non-enrollment controlled program. (Also see page 3 “Enrollment Controls”).

Registration – Each semester, you register for classes by planning what you need to take (referring to this *Handbook*, by checking with your adviser, and then by following the instructions in the *Schedule of Courses* that is published each semester. You should register as early as possible – **courses fill up quickly!**

Re-ordering your course schedule from the “sample schedule” will not necessarily delay graduation. The key to completing 126 credits over 4 years is to average approximately 16 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. Needed credits may be able to be taken during the summer (not necessarily at University Park). Some students will elect to attend for a 9th semester. Some electives are not offered every semester, so please be careful in your scheduling. This is especially true for co-op students.

Prerequisite Courses – If a CMPEN or CMPSC course has a prerequisite course(s) specified you must complete the prerequisite course with an appropriate grade before taking the successor course. For most courses an appropriate grade is a grade of D or higher. **However, if the prerequisite course is a “C or higher” course, the appropriate grade is a C or higher.** Waiving of prerequisites is not normally approved.

Schedule Changes – Schedule adjustments (course adds/drops) may be made online using **elion** during the first 10 calendar days of each semester. Detailed instructions, costs, and deadlines are provided in the *Schedule of Courses*. After this time, you may still adjust your schedule, but any change is considered a late add or a late drop. *You have a limit of 16 late-drop credits, so consultation with your adviser is important.* (REMEMBER: A student who has not yet been admitted to the major should seek advice at the **Engineering Advising Center**; a student who has been admitted should see the Department Undergraduate Adviser). Excessive dropping of courses may affect your eligibility for federal financial aid.

General Education – All Baccalaureate students at the University are required to complete 46 credits of General Education. A General Education course can be identified by its course suffix. You will partially meet these requirements by taking specific courses required for the computer science major, and by following the general guidelines below.

General Education consists of the following categories:

- first year seminar - at least 1 credit - courses with the designation PSU will fulfill this requirement, as will courses with the suffix S, T or X (see NOTE below).
- writing/speaking - 9 credits - course suffix of GWS
- quantification - 6 credits - suffix of GQ
- health and physical activity - 3 credits - suffix GHA
- natural sciences - 9 credits - suffix GN
- arts - 6 credits - suffix GA
- humanities - 6 credits - suffix GH
- social and behavioral sciences - 6 credits - suffix GS

Note: Some campuses do not have a first year seminar requirement, but instead require participation in a first year experience. If you started at such a campus you will need to take 1 additional credit of department list course work.

College of Engineering students will follow the University's General Education guidelines; refer to the College of Engineering *Undergraduate Programs Guide* and to the University's **Baccalaureate Degree Programs Bulletin** for a complete list of available courses. **Note that there are some restrictions in regards to the selection of the natural science elective (GN) – see page 12.**

Writing Requirement – All Penn State students have a Writing Across the Curriculum graduation requirement. You must complete at least 3 credits of writing-intensive courses selected from “W” courses offered within the major or college of enrollment. Courses in the computer science major that fulfill this requirement are CMPSC 483W (Software Design Methods) and CMPSC 431W (Introduction to Database Management Systems).

US & International Cultures Requirement – Courses approved to fulfill this requirement will be designated as US, IL, or both US and IL. Students must complete 3 credits in United States Cultures (US) and 3 credits in International Cultures (IL). If a student takes a 3-credit course that is both US and IL, to complete the requirement, he/she must take another 3-credit course that is US, IL, or both US and IL. Education abroad courses and other credit-bearing experiences such as internships that meet this requirement will be designated as US, IL, or both US and IL. Most students complete this requirement by selecting GA, GS or GH courses which also satisfy the US/IL requirement.

Graduation Requirements – To graduate from the University, every student must:

- (1) Complete the course requirements for his or her major;
- (2) Earn at least a 2.0 cumulative grade-point average for all courses taken at the University; and
- (3) Earn at least a C in each of these courses: CMPSC 121, CMPSC 122, CMPSC 221, CMPSC 360, CMPEN 271, CMPSC 311, CMPEN 331, CMPSC 473, CMPSC 461, CMPSC 465, MATH 140, MATH 141, MATH 230, PHYS 211, PHYS 212.

Credit Acquisition – In addition to taking courses at any Penn State campus, you may be able to earn credit through Independent Learning (World Campus) or by transferring credits from another school. Before taking a course at another university, check with the Admissions office and your adviser to be sure the course will transfer usefully. **Note that CMPSC 473, CMPSC 461, CMPSC 464, CMPSC 465 and the writing courses (CmpSc 431W or CmpSc 483W) must be taken at Penn State.**

Cooperative Education Program – 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.

If you have interest in the co-op program, you should obtain advising no later than your fourth semester from the designated co-op adviser, who will help you plan work and study schedules. You may earn up to 3 credits toward graduation in the Department List requirements.

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) toward graduation in the Department List requirements.

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, 863-2635) may earn honors in computer science by completing a dissertation with a member of the CSE faculty. See an honors adviser if you are interested in finding out more. (The department office, 342G Information Sciences and Technology 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) Engineering Entrepreneurship
- 3) Mathematics
- 4) Business/Liberal Arts

Other Issues – For additional information on minors, withdrawal, leaves of absence, concurrent majors, change of major, satisfactory/unsatisfactory credits, and other academic issues, refer to **University Faculty Senate Policies for Students**. For information on campus and community resources (parking, libraries, museums, etc.; referrals for returning adult students, minority students, veterans, women), refer to *Easy Access*, available during orientation and published by Student Life.

Waivers & Exceptions - All exceptions made in the degree requirements must be approved and documented using a College of Engineering petition form found and submitted online (<http://www.engr.psu.edu/e-petition/>). Inquiries about exceptions and general degree requirements should be taken to the Department of Computer Science and Engineering Office (342G Information Sciences and Technology Building), to your adviser, or to the Engineering Advising Center. (Note that petitions which require College level approval (exceptions/waivers to College & University requirements) will NOT be accepted during the semester that you plan to graduate).

Academic Integrity – Recognizing not only the value of integrity in the academic environment, but also its value for the practicing computer scientist 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.”

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 sections of your code or write sections of code for another student. 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.

Computer Science Topics – Students achieve breadth in computer science through a series of required courses. Background in software related areas is gained through CMPSC 121, CMPSC 122, CMPSC 221, CMPSC 311, CMPSC 465, CMPSC 461, and CMPSC 473. Background in theory is gained through CMPSC 360, CMPSC 465, and CMPSC 464. Background in hardware areas is gained through CMPEN 271, and CMPEN 331. Though taken infrequently by computer science majors, the course CMPEN 472 examines hardware and software aspects of microcomputer systems. It is recommended that you take one

programming course a semester (CmpSc 121, 122, 221, 311, 473) until CmpSc 473 is complete (if possible). Although it is recommended that you take CmpSc 121 in your first semester, your graduation will not be delayed if you take CmpSc 121 in the second semester.

Specialization is obtained by the students' selection of technical electives. Students must select 12 credits of technical electives (6 credits from CMPSC 471, CMPSC 450, CMPSC 458, CMPSC 443, CMPSC 442, CMPSC 448, CMPSC 451, CMPSC 455, CMPSC 456, CMPSC 467, CMPSC 468, CMPSC 475, CMPEN 362, CMPEN 454, and EE 456, select 3 credits from any 400-level CMPSC/CMPEN course, and select 3 credits from CMPSC 483W or CMPSC 431W).

Issues related to the integration of hardware and software, and hardware-software tradeoffs are discussed in the required courses CMPSC 311, CMPEN 331, and CMPSC 473, as well as some elective courses such as CMPEN 472 and CMPEN 473.

Students receive an appropriate introduction to various specialized mathematics topics in a sequence of required courses that include: CMPSC 360, STAT 318, STAT 319, and MATH 220. A variety of methods for modeling computer processes and systems are introduced in the required courses CMPSC 465, CMPEN 331, and CMPSC 473.

Students can learn to use a number of computer-aided design tools through certain laboratory courses and in regular lecture courses. These include a digital schematic capture and simulation tool in CMPEN 271; a hardware design language and a microprocessor emulation system in CMPEN 473; a hardware description language similar in CMPEN 431; logic design CAD tools in CMPEN 471; VLSI CAD tools in CMPEN 411; and computer vision software tools in CMPEN/EE 454.

All students learn at least three programming languages, JAVA, C, and C++. Assembly language is studied in CMPEN 331 and CMPEN 472. In CMPSC 461, students are exposed to various language features associated with any programming language. Students make extensive use of both Microsoft and UNIX operating systems.

Program Requirement Summary Chart – On the next pages, you will find a semester-by-semester chart of what courses to take with notes describing any choices to be made or restrictions to be followed. Please realize that although all the courses listed are required for the degree, they need not be taken during the semesters shown in the charts. 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 time frame allowing you to meet entrance to major requirements.** Also remember that a course that is designated as **C required** must be completed with a C or higher in order to both move on to a course for which it is a prerequisite and to graduate. It is suggested that, if possible, you not wait until your last semester to take C required courses. A total of 126 credits are required for graduation.

Sample Schedule of Courses by Semester

SEMESTER 1

16 credits

MATH 140 or 140E GQ (Calculus I)*	4
CMPSC 121 GQ (Intro. to Programming Tech.)*	3
ENGL 15 or 30 GWS (Rhetoric & Comp.)	3
GA, GH, or GS course	3
GA, GH, or GS course	3

SEMESTER 2

15 credits

MATH 141 or 141E GQ (Calculus II)*	4
PHYS 211 (Mechanics)*	4
CMPSC 122 (Intermediate Programming)*	3
GA, GH, or GS course	3
First Year Seminar ^{xi}	1

SEMESTER 3

16 credits

CMPSC 221 (OOP with Web Applications)*	3
MATH 230 (Calculus I)*	4
MATH 220 (Matrices)	2
PHYS 212 (Electricity & Magnetism)*	4
CAS 100 A/B (Effective Speech)	3

SEMESTER 4

14-15 credits

CMPEN 271 (Intro to Digital Systems)*	3
Natural Science (GN) ^{vi}	2-3
GA, GH, or GS course	3
ENGL 202C GWS (Technical Writing)	3
CMPSC 311 (Systems Programming)*	3

SEMESTER 5

16 credits

CMPEN 331 (Comp. Organization & Design)*	3
CMPSC 360 (Discrete Math for CMPSC)*	3
GA, GH, or GS course	3
STAT 318 (Elementary Probability)	3
Foreign Language (level 002 proficiency) ^{ix}	4

SEMESTER 6

15 credits

CMPSC 465 (Data Structures & Algorithms)*	3
CMPSC 473 (Operating Systems)*	3
STAT 319 (Applied Statistics in Science)	3
CMPSC Computer Science Elective ⁱⁱ	3
GA, GH, or GS course	3

SEMESTER 7

17.5 credits

CMPSC 483W or CMPSC 431W	3
CMPSC 464 (Intro. to the Theory of Comput.)	3
Department List (General Elective) ^x	4
Department List (General Elective) ^x	3
Supporting Course ^{viii}	3
Health & Physical Activity (GHA) ^v	1.5

SEMESTER 8

16.5 credits

CMPSC 461 (Programming Lang. Concepts)*	3
Department List (General Elective) ^x	3
Supporting Course ^{viii}	3
CMPSC Computer Science Elective ⁱⁱ	3
CMPSC/CMPEN 400-level ^{**}	3
Health & Physical Activity (GHA) ^v	1.5

Subscripts in Roman numerals refer to the Graduation Requirements Notes on the following pages.

* A grade of C or better in these courses is required for graduation; (MATH 140, MATH 141, MATH 230, PHYS 211, PHYS 212, and CMPSC 122 require a C or better for entrance to the major). If a course requires a "C" or better and the course is a prerequisite for another course, a "C" is required to meet the prerequisite.

** Select 3 credits from any 400-level CMPSC/CMPEN course (may not duplicate material already taken or required). No CMPSC 494H or CMPSC 496 may be substituted.

GRADUATION REQUIREMENTS NOTES

Many of the courses below have prerequisites; some prerequisites are shown in parentheses; others are given in the Bulletin.

I. Computer Science and Engineering (33 credits):

- CMPSC 121 GQ (3) – Introduction to Programming Techniques
(prerequisite: MATH 110 or MATH 140 concurrently or as a prerequisite)
- CMPSC 122 (3) – Intermediate Programming
(prerequisite: CMPSC 121)
- CMPSC 221 (3) – Object Oriented Programming with Web-Based Applications
(prerequisite: CMPSC 122)
- CMPSC 360 (3) – Discrete Mathematics for Computer Science
(Concurrent: CMPSC 122)
- CMPEN 271 (3) – Introduction to Digital Systems
(Concurrent: PHYS 212)
- CMPSC 311 (3) – Systems Programming
(prerequisite: CMPSC 221)
- CMPEN 331 (3) – Computer Organization and Design
(prerequisite: CMPEN 271 or CMPEN 270; CMPSC 121 or CMPSC 201)
- *CMPSC 473 (3) – Operating Systems
(prerequisite: CMPSC 311; CMPEN 331)
- *CMPSC 461 (3) – Programming Language Concepts
(prerequisite: CMPSC 221; CMPSC 360)
- *CMPSC 464 (3) – Introduction to the Theory of Computation
(prerequisite: CMPSC 465)
- *CMPSC 465 (3) – Data Structures and Algorithms
(prerequisite: CMPSC 360 or MATH 311W)

*Neither transfer credits nor study abroad credits may substitute.

II. Computer Science Electives (12 credits):

One course must be selected from CMPSC 483W or CMPSC 431W to satisfy the writing intensive requirement. **Some courses are NOT offered every semester or even every year.**

Select 3 credits from any 400-level CMPSC or CMPEN course. (Courses offered at non-UP locations which cover duplicate material may not be used, e.g. CMPSC 425).

Select 6 credits from:

- CMPSC 450 (3) – Concurrent Scientific Programming
(prerequisite: CMPSC 121, CMPSC 201 or CMPSC 202; MATH 220; MATH 230 or MATH 231)
- CMPSC 458 (3) – Fundamentals of Computer Graphics
(prerequisite: CMPSC 311; MATH 220; MATH 230 or MATH 231)
- CMPSC 443 (3) – Introduction to Computer and Network Security
(prerequisite: CMPSC 473; CMPEN 362)
- CMPSC 442 (3) – Artificial Intelligence
(prerequisite: CMPSC 122 or equivalent. Concurrent: CMPSC 465)
- CMPSC 448 (3) – Machine Learning and Algorithmic AI
(prerequisite: STAT 318, STAT 319, MATH 230, MATH 220)
- CMPSC 451 (3) – Numerical Computations
(prerequisite: 3 credits of programming; MATH 230 or MATH 231)
Note: Students may take only one course for credit from CMPSC 451 and 455.

- CMPSC 455 (3) – Introduction to Numerical Analysis I
(prerequisite: MATH 220; MATH 230 or MATH 231; and 3 credits of programming)
Note: Student may take only one course for credit from CMPSC 451 and 455.
- CMPSC 456 (3) – Introduction to Numerical Analysis II
(prerequisite: CMPSC 455)
- CMPSC 467 (3) – Factorization and Primality Testing
(prerequisite: CMPSC 360 or MATH 311W)
- CMPSC 471 (3) – Introduction to Compiler Construction
(prerequisite: CMPSC 461)
- CMPSC 475 (3) – Applications Programming
(prerequisite: CMPSC 221 or CMPSC 425; CMPSC 311 or CMPSC 312;
CMPSC 462 or CMPSC 465)
- CMPEN 362 (3) – Communication Networks
(prerequisite: 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
(prerequisite: CMPEN 331 or CMPEN 371)
- CMPEN 454 (3) – Fundamentals of Computer Vision
(prerequisite: MATH 230 or MATH 231; CMPSC 121 or CMPSC 201)
- EE 456 (3) – Introduction to Neural Networks
(prerequisite: CMPSC 201 or CMPSC 202; MATH 220)

Select 3 credits from:

- CMPSC 483W (3) – Software Design Methods
(prerequisite: CMPSC 221; CMPSC 465; ENGL 202C)
- OR
- CMPSC 431W (3) – Database Management Systems
(prerequisite: CMPSC 221; ENGL 202C)

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

**A student may take only one course for credit from CMPSC (MATH) 451 and 455.*

III. Communications (9 credits):

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

IV. Quantification and Statistics (20 credits):

Mathematics (14 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 230 (4) – Calculus and Vector Analysis
combination of MATH 231 (2) and MATH 232 (2) may be substituted

Probability and Statistics (6 credits):
Either STAT (MATH) 318 and 319
or STAT (MATH) 414 and 415
or MATH 444 and 445
(STAT/MATH 418 may substitute for 318 or 414)

V. Health Sciences and Physical Education (3 credits):

The Health Science/Physical Activity (ESACT) 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 GHA requirement.

VI. Natural Sciences (10-11 credits):

Physics (8 credits):
PHYS 211 GN (4) – General Physics (mechanics)
PHYS 212 GN (4) – General Physics (electricity, magnetism)

Additional natural science (2-3 credits):
Select 2 credits from PHYS 213 GN(2), 214 GN(2), or 3 credits from any GN except as excluded below.

These GN courses are NOT acceptable:

ASTRO 1, 10, 11, 120, 140; all BI SC courses; All below CHEM 110 (except 3 credits of CHEM 106 can be used); PHYS 250, 251, all below PHYS 211, GEOSC 20

VII. Arts, Humanities, Social and Behavioral Sciences, US/IL (18 credits):

Six credits are required in each of the 3 categories: Arts (A), Humanities (H), and Social and Behavioral Sciences (S), as listed under the University's General Education Guidelines [see the University's **Baccalaureate Degree Programs Bulletin**]. See page 4 [this handbook], **General education**, for an explanation of the 9-6-3 sequence as it pertains to AHS courses. You may use your Arts, Humanities, or Social or Behavioral Sciences selections to fulfill the University's US & International Cultures requirement (see page 5 [this handbook], **US/IL requirement***). A work chart follows.

Arts

Humanities

Social Sci.

US/IL Course

For US/IL courses, see **General Education and US & International Cultures in the Curriculum on-line and the *Semester Course Schedules*. The College of Engineering encourages you to be a Globally Ready student in which *Global Readiness is defined as having the knowledge and appreciation of the global nature of engineering and related professions, as well as the challenges and opportunities associated with contemporary worldwide issues. Students should graduate, being ready to practice their profession in a global context by being sensitive to and respectful of the differences that affect professional practice throughout the world.* To assist you in being Globally Ready the College of Engineering encourages you to select as an IL course one of the courses off the list which may be found at:*

<http://www.engr.psu.edu/global/students/illimited.htm>.

VIII. Supporting Courses (6 credits):

Guidelines: Choose six credits of 400-level non-CMPSC/CMPEN courses, having a common theme, that support a career in computer science. Acceptable alternatives include 6 credits in mathematics (MATH) and/or statistics (STAT); 6 credits in information sciences (IST), or 6 credits in engineering leadership/entrepreneurship (ENGR, excluding co-op credits). Any deviation from these alternatives requires a petition. Because a petition could be denied, you should seek approval before scheduling the course. Note that you may need to take more than two courses to satisfy the 6-credit requirement.

Examples of courses that would be acceptable include:

- Most courses with the prefix MATH, STAT, IST, EDSGN, or ENGR (excluding co-op credits). These are currently the types of courses most commonly used to fulfill the Supporting Courses requirement.
- Technical courses at the 400-level (not CMPSC/CMPEN); e.g., chemistry, physics, biology, engineering (because they provide additional technical depth or breath).
- Courses that relate to business or management; e.g., finance, accounting, marketing, economics (because most CMPSC majors must work in a business environment).
- Courses in linguistics (because the study of language relates to programming languages)
- Psychology, if the courses relate to cognition, perception, learning, memory, vision (because they relate to AI), but not say development through adulthood, abnormal psychology, social psychology, religious approaches to psychology.
- Philosophy, if the courses relate to ethics, logic, science, language, or similar topics.
- Foreign language courses that relate to communication in the language (because of its value in a global work environment).

Examples of courses that fail to meet the spirit of the requirement include:

- Crime, Law, and Justice (their one course on computer security is remedial for CMPSC majors).
- History, Sociology, English, Education, Communication, Instructional Systems, Military.
- Art, even though it might be loosely related to computer graphics, or web development.
- Music, unless both courses deal with electronic music.
- MATH (STAT) 414, 415, 418, MATH 444, 445 (these courses can only be applied to the statistic's requirement in Section IV).
- MATH (CMPSC) 451, 455, 456, 467 (cross-listed with CMPSC).
- MATH 470, 471, 493 (designed for education majors).

IX. Foreign Language Proficiency (4 credits)

CMPSC majors are required to demonstrate proficiency equivalent to two semesters of a single foreign language. Since Penn State now requires the equivalent of one semester of a foreign language for admission, most students can meet the CMPSC foreign language requirement in one of the following ways:

- Complete the 4th or higher year of a single foreign language in high school (submit an online COE petition and upload a copy of your HS transcript with the petition). You must still make up the four credits, however. In effect, four credits are added to your Department List requirement.
- Complete the 2nd (or higher) semester of one foreign language; e.g. SPAN 2.
- Complete two semesters (8 credits) of a NEW foreign language (other than the one you took in high school). Four of these credits can be applied to Department List electives.

If you were admitted to Penn State with a foreign language deficiency, you must complete two semesters (8 credits) of a single foreign language; however, only 4 of those credits can be applied to your degree requirements.

X. Department List (General Elective) Guidelines (10-14 credits)

Choose enough credits to bring the total number of credits up to at least 126. If your US/IL course was not an Arts, Humanities, Social or Behavioral Sciences course, it may be counted in this list. (For US/IL courses, see the *General Education and US & International Cultures in the Curriculum* booklet). These are sometimes called approved free electives or general electives, but the following restrictions apply:

- no courses not satisfying minimum requirements for baccalaureate degree program (see course descriptions in University *Bulletin*)
 - no courses described as intended for non-science or non-technical majors in course descriptions in 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.
 - not ENGL 4, 5, or any other remedial English
 - none of the following:
 - Astronomy (ASTRO) 1, 10, 11, 120, 140
 - Biological Science (BI SC) 1, 2, 3, 4
 - Chemistry (CHEM) 1, 3, 108, 101
 - Computer Science (CMPSC) 100, 203
 - Earth and Mineral Sciences (EM SC) 150
 - English as a Second Language (ESL) 004
 - Language and Literacy Education (LL ED) 5, 10
 - Mathematics (MATH) 200, MATH below 140
 - Philosophy (PHIL) 12
 - Physical Science (PH SC) 7
 - Physics (PHYS) 250, 251, PHYS below 211
 - Science, Technology, and Society (S T S) 150
 - Speech Communication (CAS) 126, 283
 - Statistics (STAT or MATH) below 318, 401
 - STAT (MATH) 318, STAT (MATH) 319, STAT (MATH) 414, STAT (MATH) 415, STAT (MATH) 418, MATH 444, 445
 - no more than 3 credits of ROTC
 - no more than 6 credits of music performance courses
 - 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
 - no more than 3 credits of CHEM 106
- IST courses except for the following:**
- IST 140 – may never be used
 - IST 210 – may not be used if the student takes CMPSC 431W
 - IST 220 – may not be used if the student takes CMPEN 362
 - IST 242 – may never be used
 - IST 230 – may never be used
 - IST 261 – may never be used
 - IST 311 – may never be used
 - IST 361 – may never be used

XI. First Year Seminar (1 credit):

Small interactive classes that allow first-year students to meet faculty and alumni, explore different majors and career opportunities, or focus on hands-on projects and skill development. If you started at a campus that did not require First Year Seminar or are a transfer credit then you must add an additional credit to the Department List requirement.