School of Computer Science

Martial Hebert, Dean
Thomas Cortina, Associate Dean for Undergraduate Programs
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Location: GHC 4115
www.cs.cmu.edu/undergraduate-programs (http://www.cs.cmu.edu/undergraduate-programs/)

Carnegie Mellon founded one of the first Computer Science departments in the world in 1965. As research and teaching in computing grew at a tremendous pace at Carnegie Mellon, the university formed the School of Computer Science (SCS) at the end of 1988. Carnegie Mellon was one of the first universities to elevate Computer Science into its own academic college at the same level as the Mellon College of Science and the College of Engineering. Today, SCS consists of seven departments and institutes, including the Computer Science Department that started it all, along with the Human-Computer Interaction Institute, the Institute for Software Research, the Computational Biology Department, the Language Technologies Institute, the Machine Learning Department, and the Robotics Institute. Together, these units make SCS a world leader in research and education. A few years ago, SCS launched two new undergraduate majors in Computational Biology and Artificial Intelligence (the first of its kind in the United States), and this year, SCS begins a fourth undergraduate major in Human-Computer Interaction. These new majors, along with the highly-ranked Computer Science major, give students in SCS distinct paths in the field of computing with ample opportunities in industry and advanced research.

The School of Computer Science offers the following majors and minors:
- B.S. in Artificial Intelligence
- B.S. in Computational Biology
- B.S. in Computer Science
- B.S. in Human-Computer Interaction
- Bachelor's in Computer Science and Art (joint with the College of Fine Arts)
- Additional major in Computational Biology
- Additional major in Computer Science
- Additional major in Human-Computer Interaction
- Additional major in Robotics
- Minor in Computer Science
- Minor in Computational Biology
- Minor in Human-Computer Interaction
- Minor in Language Technologies
- Minor in Machine Learning
- Minor in Neural Computation
- Minor in Robotics
- Minor in Software Engineering

Information for these majors and minors can be found through the navigation menu or through the links below:
- Artificial Intelligence (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/artificialintelligence/) (B.S. degree)
- Computational Biology (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/undergraduatecomputationalbiology/) (B.S. degree, additional major, minor)
- Computer Science (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/undergraduatecomputerscience/) (B.S. degree, additional major, minor)
- Human-Computer Interaction (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/humancomputerinteractionprogram/) (B.S. degree, additional interdisciplinary major, minor)
- SCS additional majors and minors (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/additionalmajorsandminors/)

Students who apply to, and are directly admitted into, the School of Computer Science can choose between four primary majors: Artificial Intelligence, Computational Biology, Computer Science and Human-Computer Interaction. Students with artistic and computing interests may be given the option to pursue a major in Computer Science and Art. Suitably prepared students from other Carnegie Mellon colleges are eligible to apply for internal transfer to the School of Computer Science and will be considered for transfer if grades in specific requirements are sufficiently high and space is available. Consult the program websites for specific requirements for transfer requests. Computation-oriented programs are also available within the Mellon College of Science, the Dietrich College of Humanities and Social Sciences, the College of Engineering and the College of Fine Arts.

Policies & Procedures

Academic Standards and Actions

Grading Practices

Grades given to record academic performance in SCS are detailed under Grading Practices at Undergraduate Academic Regulations (http://coursecatalog.web.cmu.edu/servicesandoptions/undergraduateacademicregulations/).

Dean's List WITH HIGH HONORS

SCS recognizes each semester those undergraduates who have earned outstanding academic records by naming them to the Dean's List with High Honors. The criterion for such recognition is a semester quality point average of at least 3.75 while completing a minimum of 36 factorable units and earning no incomplete grades.

Academic Actions

In the first year, quality point averages below 1.75 in either semester invite an academic action. For all subsequent semesters an academic action will be taken if the semester quality point average or the cumulative quality point average (excluding the first year) is below 2.00.

Probation: The action of probation will be taken in the following cases based on QPA:
1. One semester of the first year is below 1.75 QPA;
2. The semester QPA of a student in good standing beyond the first year falls below 2.00.

The term of probation is one semester as a full-time student. First year students are no longer on probation at the end of the second semester if the second semester's QPA and the cumulative QPA is 1.75 or above. Students in the third or subsequent semester of study are no longer on probation at the end of one semester if the semester QPA and cumulative QPA (excluding the first year) are 2.00 or above.

Probation Continued: A student who has had one semester on probation and is not yet meeting minimum requirements but whose record indicates that the standards are likely to be met at the end of the next semester of study may be continued on probation, based on advisor recommendation. This action is normally taken only when a student's semester QPA is above 2.0 but their cumulative QPA is not yet above 2.0.

Suspension: A student who does not meet minimum standards based on QPA at the end of one semester of probation can be suspended:
- A first year student will be suspended if the QPA from each semester is below 1.75.
- A student on probation in the third or subsequent semester of study will be suspended if the semester QPA is below 2.00.

The minimum period of suspension is one academic year (two non-summer semesters). Suspension is meant to allow a student to take a pause from their academic studies to address the issues that are causing poor academic performance. At the end of that period a student may return to campus (on probation) by:
1. completing a Return from Leave form from the HUB, and
2. submitting an additional written statement to the SCS Associate Dean for Undergraduate Programs, minimum one page, that outlines what the student did while on leave to address the issues that led to the suspension and that would indicate future success on return, and
3. (optional) submitting up to two letters of support from individuals supporting the student's return, and
4. written approval from the student's academic advisor and the Associate Dean for Undergraduate Programs, in consultation with the Office of Student Affairs and the Office of International Education as appropriate.

Students who have been suspended or have withdrawn are required to absent themselves from the campus (including residence halls and Greek houses) within a maximum of two days after the action and to remain off the campus for the duration of the time specified. This action includes
and wishing to transfer to Computer Science or pursue a dual degree
Undergraduate students admitted to colleges at CMU other than SCS
Transfer into SCS / Dual-Degree
available space in the intended major.
Transfers are approved based on demonstrated interest, ability, and
intended major for more information about specific course requirements and
should consult with their academic advisor and the program director of the
semester break during the semester the transfer is desired. These students
major to another SCS major may do so by applying for transfer by mid-
Internal Transfer within SCS
more information.
Students returning from a leave of absence are required to submit a Return
From Leave of Absence form to their academic advisor for approval by the
HUB and have this signed by their academic advisor and SCS Associate
Students who take a leave of absence up to the last day to drop classes will have all of their classes dropped.
Students may apply for transfer by the mid-semester break in the semester when the final course(s) of the six required courses will be completed. In the case of course(s) in progress, the mid-semester grades will be used in the QPA calculation. The decision to allow transfer or dual degree will be made by committee based on the student's academic performance (in the specified courses and in their courses overall if necessary), additional involvement in SCS and other computing-related activities, and availability of space in the student's class level. Students should consult the SCS Undergraduate Office for complete information concerning minimum requirements, instructions and deadlines.

Leave of Absence and Return from Leave of Absence
SCS undergraduate students may elect to take a leave of absence for a variety of reasons, after consultation with their academic advisor. Students who wish to take a leave of absence must do so by the last day of classes before final exams begin and before final grades are posted (in case this is earlier). Students requesting a leave of absence must complete a form from the HUB and have this signed by their academic advisor and SCS Associate Dean for Undergraduate Programs. Students who take a leave of absence up to the last day to drop classes will have all of their classes dropped.
Students who take a leave of absence after the last day to drop classes will be assigned a grade of W (withdrawal) for all of their classes.

Students returning from a leave of absence are required to submit a Return from Leave of Absence form to their academic advisor for approval by the student's academic advisor and the SCS Associate Dean for Undergraduate Programs. In addition, the student must also supply a letter that explains the reason for the leave, the actions that were performed during the leave to prepare the student for a successful return, and a description of the student's campus resources, if required, that would be used by the student in order to increase the likelihood of success. Students returning from a leave are also encouraged to provide up to two letters of support from people close to the student (e.g. family, friends, clergy, teachers, coaches, others as appropriate). Requests to return are reviewed by the student's academic advisor, the Associate Dean and the Student Affairs liaison to determine eligibility and any resources that need to be put into place to assist the student upon return. Contact the SCS Undergraduate Office (GHC 4115) for more information.

Internal Transfer within SCS
First year students admitted to SCS are considered undeclared during their first year. These students declare their SCS major in the second semester of their first year of study. SCS students who wish to transfer from one SCS major to another SCS major may do so by applying for transfer by mid-
semester break during the semester the transfer is desired. These students should consult with their academic advisor and the program director of the intended major for more information about specific course requirements and academic plans. Internal SCS transfers do not have any grade requirements. Transfers are approved based on demonstrated interest, ability, and available space in the intended major.

Transfer into SCS / Dual-Degree
Undergraduate students admitted to colleges at CMU other than SCS and wishing to transfer to Computer Science or pursue a dual degree in Computer Science should consult with the Director of the Computer Science major during their first year. Students wishing to transfer to Computational Biology or pursue a dual degree in Computational Biology should consult with the Assistant Department Head for Education in the Computational Biology Department during their first year. See the individual program pages for Computer Science (http://
coursescatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/
dergraduatecomputerscience/) and Computational Biology (http://
coursescatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/
dergraduatecomputationalbiology/) for locations.
• For the Computer Science major, students must complete 21-127 (or equivalent), 15-122, 15-150, 15-210, 15-213, 15-251 with an expected overall QPA over these six courses of 3.6 or higher and an overall QPA of at least 3.0 in order to be considered for transfer or dual degree.
• For the Computational Biology major, students must complete 21-127 (or equivalent), 15-122, 15-251, 15-351 (or 15-210*), 63-121 and 02-250 with an expected overall QPA over these six courses of 3.6 or higher and an overall QPA of at least 3.0 in order to be considered for transfer or dual degree. (*Students who take 15-210 will need to also take 15-150; this course is not required for the B.S. in Computational Biology but can count as an elective.)
• Consult the websites for the Human-Computer Interaction and Artificial Intelligence majors for guidelines for transfer.

External Transfer
A student currently enrolled at another university or college who wishes to transfer to SCS should first apply through the Office of Admission. If the Office of Admission believes the applicant meets admission guidelines, the student's record is sent to SCS for evaluation. Admission is based on seat availability, overall academic performance and course rigor from the student's current institution, ability to complete the rigorous SCS program on time, and the application material including recommendations and reflection essay(s). It is important to note that extremely few external transfers are admitted to the SCS program at Carnegie Mellon University due to space limitations.

Graduation Requirements
1. A requirement for graduation is the completion of the program specified for a degree with a cumulative quality point average of 2.00 or higher for all courses taken after the first year.
2. Students must be recommended for a degree by the faculty of SCS.
3. A candidate for the bachelor's degree must complete at the University a minimum of four semesters of full-time study, or the equivalent of part-time study, comprising at least 180 units of course work.
4. Students will be required to have met all financial obligations to the university before being awarded a degree.

A student who does not meet the QPA requirement above must petition SCS College Council for a waiver of the first requirement.

General Education Requirements
All undergraduate degrees in the School of Computer Science include depth in their particular field of study but also breadth through the general education requirements. General education requirements are part of SCS degrees to give students an opportunity to learn more about the world from scientific and humanistic points of view. These additional skills are useful for graduates since computing is often embedded in domains that are not entirely within the bounds of computing. SCS students will need to use their computing skills to solve problems alongside scientists and engineers, artists, social and cognitive scientists, historians, linguists, economists and business experts, and SCS students will need to communicate effectively and understand the ethical implications of their work. The general education requirements help SCS students gain this broad perspective so they can work well in a wide variety of domains.
Science and Engineering

All candidates for a B.S. degree in the School of Computer Science must complete a minimum of 36 units offered by the Mellon College of Science and/or the College of Engineering (CIT).

Computational Biology majors

For Computational Biology majors, consult the Computational Biology program page for specific science and engineering requirements. The required science and engineering courses for the Computational Biology major also satisfy the General Education requirement for SCS by default.

Artificial Intelligence, Computer Science and Human-Computer Interaction majors

For Artificial Intelligence, Computer Science and Human-Computer Interaction majors, four courses in science and engineering are required, 9 units or more for each course, at least one course must have a laboratory component and at least two courses must be from the same department.

Non-lab courses that are usually taken by AI, CS and HCI majors to satisfy this requirement are given in the list below. (Consult your academic advisor for additional choices available each semester.)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-223</td>
<td>Personalized Medicine: Understanding Your Own Genome</td>
<td>9</td>
</tr>
<tr>
<td>03-121</td>
<td>Modern Biology</td>
<td>9</td>
</tr>
<tr>
<td>03-125</td>
<td>Evolution</td>
<td>9</td>
</tr>
<tr>
<td>03-132</td>
<td>Basic Science to Modern Medicine</td>
<td>9</td>
</tr>
<tr>
<td>03-133</td>
<td>Neurobiology of Disease</td>
<td>9</td>
</tr>
<tr>
<td>06-100</td>
<td>Introduction to Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>06-221</td>
<td>Thermodynamics</td>
<td>9</td>
</tr>
<tr>
<td>09-105</td>
<td>Introduction to Modern Chemistry I</td>
<td>10</td>
</tr>
<tr>
<td>09-106</td>
<td>Modern Chemistry II</td>
<td>10</td>
</tr>
<tr>
<td>09-217</td>
<td>Organic Chemistry I</td>
<td>9</td>
</tr>
<tr>
<td>09-218</td>
<td>Organic Chemistry II</td>
<td>9</td>
</tr>
<tr>
<td>09-225</td>
<td>Climate Change: Chemistry, Physics and Planetary Science</td>
<td>9</td>
</tr>
<tr>
<td>12-100</td>
<td>Exploring CEE: Infrastructure and Environment in a Changing World</td>
<td>12</td>
</tr>
<tr>
<td>12-201</td>
<td>Geology</td>
<td>9</td>
</tr>
<tr>
<td>18-100</td>
<td>Introduction to Electrical and Computer Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-220</td>
<td>Electronic Devices and Analog Circuits</td>
<td>12</td>
</tr>
<tr>
<td>18-240</td>
<td>Structure and Design of Digital Systems</td>
<td>12</td>
</tr>
<tr>
<td>24-101</td>
<td>Fundamentals of Mechanical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>24-231</td>
<td>Fluid Mechanics</td>
<td>10</td>
</tr>
<tr>
<td>24-261</td>
<td>Statics</td>
<td>10</td>
</tr>
<tr>
<td>24-351</td>
<td>Dynamics</td>
<td>10</td>
</tr>
<tr>
<td>24-358</td>
<td>Culinary Mechanics</td>
<td>9</td>
</tr>
<tr>
<td>27-215</td>
<td>Thermodynamics of Materials</td>
<td>12</td>
</tr>
<tr>
<td>27-324</td>
<td>Introduction to Polymer Science and Engineering</td>
<td>9</td>
</tr>
<tr>
<td>33-114</td>
<td>Physics of Musical Sound</td>
<td>9</td>
</tr>
<tr>
<td>33-120</td>
<td>Science and Science Fiction</td>
<td>9</td>
</tr>
<tr>
<td>33-121</td>
<td>Physics I for Science Students</td>
<td>12</td>
</tr>
<tr>
<td>or 33-141</td>
<td>Physics I for Engineering Students</td>
<td>12</td>
</tr>
<tr>
<td>or 33-151</td>
<td>Matter and Interactions</td>
<td>12</td>
</tr>
<tr>
<td>33-142</td>
<td>Physics II for Engineering and Physics Students</td>
<td>12</td>
</tr>
<tr>
<td>or 33-152</td>
<td>Matter and Interactions II</td>
<td>12</td>
</tr>
<tr>
<td>33-224</td>
<td>Stars, Galaxies and the Universe</td>
<td>9</td>
</tr>
<tr>
<td>42-101</td>
<td>Introduction to Biomedical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>42-202</td>
<td>Physiology</td>
<td>9</td>
</tr>
<tr>
<td>85-219</td>
<td>Biological Foundations of Behavior</td>
<td>9</td>
</tr>
</tbody>
</table>

At present, courses meeting the lab requirement include:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>02-261</td>
<td>Quantitative Cell and Molecular Biology Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>03-124</td>
<td>Modern Biology Laboratory</td>
<td>9</td>
</tr>
<tr>
<td>09-101</td>
<td>Introduction to Experimental Chemistry (This 3 unit lab together with 09-105 satisfies the lab requirement.)</td>
<td>3</td>
</tr>
</tbody>
</table>

The following MCS and CIT courses cannot be used to satisfy the Science and Engineering requirement (see note below this list for additional exceptions and conditions):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>03-511</td>
<td>Computational Molecular Biology and Genomics</td>
<td>9</td>
</tr>
<tr>
<td>03-512</td>
<td>Computational Methods for Biological Modeling and Simulation</td>
<td>9</td>
</tr>
<tr>
<td>04-330</td>
<td>Fundamentals of Software Development and Problem Solving</td>
<td>12</td>
</tr>
<tr>
<td>06-262</td>
<td>Mathematical Methods of Chemical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>09-103</td>
<td>Atoms, Molecules and Chemical Change</td>
<td>9</td>
</tr>
<tr>
<td>09-108</td>
<td>The Illusion and Magic of Food</td>
<td>6</td>
</tr>
<tr>
<td>09-109</td>
<td>Kitchen Chemistry Sessions</td>
<td>3</td>
</tr>
<tr>
<td>09-110</td>
<td>The Design and Making of Skin and Hair Products</td>
<td>3</td>
</tr>
<tr>
<td>09-114</td>
<td>Basics of Food Science</td>
<td>3</td>
</tr>
<tr>
<td>09-204</td>
<td>Professional Communication Skills in Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>09-209</td>
<td>Kitchen Chemistry Sessions</td>
<td>3</td>
</tr>
<tr>
<td>09-231</td>
<td>Mathematical Methods for Chemists</td>
<td>9</td>
</tr>
<tr>
<td>12-215</td>
<td>Introduction to Professional Writing in CEE</td>
<td>9</td>
</tr>
<tr>
<td>12-271</td>
<td>Computed and Data Science for Civil &amp; Environmental Engineering</td>
<td>9</td>
</tr>
<tr>
<td>18-090</td>
<td>Twisted Signals: Multimedia Processing for the Arts</td>
<td>10</td>
</tr>
<tr>
<td>18-200</td>
<td>ECE Sophomore Seminar</td>
<td>1</td>
</tr>
<tr>
<td>18-202</td>
<td>Mathematical Foundations of Electrical Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-213</td>
<td>Introduction to Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-330</td>
<td>Introduction to Computer Security</td>
<td>12</td>
</tr>
<tr>
<td>18-334</td>
<td>Network Security</td>
<td>12</td>
</tr>
<tr>
<td>18-335</td>
<td>Secure Software Systems</td>
<td>12</td>
</tr>
<tr>
<td>18-411</td>
<td>Computational Techniques in Engineering</td>
<td>12</td>
</tr>
<tr>
<td>18-441</td>
<td>Computer Networks</td>
<td>12</td>
</tr>
<tr>
<td>18-461</td>
<td>Introduction to Machine Learning for Engineers</td>
<td>12</td>
</tr>
<tr>
<td>18-462</td>
<td>Principles and Engineering Applications of AI</td>
<td>12</td>
</tr>
<tr>
<td>18-465</td>
<td>Advanced Probability &amp; Statistics for Engineers</td>
<td>12</td>
</tr>
<tr>
<td>18-482</td>
<td>Telecommunications Technology and Policy for the Internet Age</td>
<td>12</td>
</tr>
<tr>
<td>18-487</td>
<td>Introduction to Computer Security</td>
<td>12</td>
</tr>
<tr>
<td>18-540</td>
<td>Rapid Prototyping of Computer Systems</td>
<td>12</td>
</tr>
<tr>
<td>19-101</td>
<td>Introduction to Engineering and Public Policy</td>
<td>12</td>
</tr>
<tr>
<td>19-211</td>
<td>Ethics and Policy Issues in Computing (or 17-200)</td>
<td>9</td>
</tr>
<tr>
<td>19-213</td>
<td>The American Railroad: Decline and Renaissance in the Age of Deregulation</td>
<td>6</td>
</tr>
<tr>
<td>19-301</td>
<td>Decision Making Methods for Engineers and Scientists</td>
<td>9</td>
</tr>
<tr>
<td>19-303</td>
<td>Cryptocurrencies, Blockchains and Applications Var.</td>
<td>9</td>
</tr>
<tr>
<td>19-318</td>
<td>Public Policy and Regulations</td>
<td>9</td>
</tr>
<tr>
<td>19-325</td>
<td>Technology and Policy Writing for Lay Audiences</td>
<td>9</td>
</tr>
<tr>
<td>19-351</td>
<td>Applied Methods for Technology-Policy Analysis</td>
<td>9</td>
</tr>
<tr>
<td>19-365</td>
<td>Water Technology Innovation and Policy</td>
<td>9</td>
</tr>
<tr>
<td>19-402</td>
<td>Telecommunications Technology and Policy for the Internet Age</td>
<td>12</td>
</tr>
<tr>
<td>19-403</td>
<td>Policies of Wireless Systems</td>
<td>12</td>
</tr>
<tr>
<td>19-411</td>
<td>Science and Innovation Leadership for the 21st Century: Firms, Nations, and Tech</td>
<td>9</td>
</tr>
<tr>
<td>19-421</td>
<td>Emerging Energy Policies</td>
<td>9</td>
</tr>
<tr>
<td>19-425</td>
<td>Sustainable Energy for the Developing World</td>
<td>9</td>
</tr>
<tr>
<td>19-433</td>
<td>Data Science for Technology, Innovation and Policy</td>
<td>9</td>
</tr>
<tr>
<td>19-534</td>
<td>Usable Privacy and Security</td>
<td>9</td>
</tr>
</tbody>
</table>
All Electrical and Computer Engineering graduate courses [18-6xx, 18-7xx, 18-8xx, 18-9xx] cannot be used for this requirement. Students interested in Engineering & Policy Program (19-xxx) courses that are not excluded above, particularly special topics courses, must consult with the CS Program Director to determine suitability for this requirement. In general, any MCS or CIT courses that are cross-listed with SCS courses or have significant mathematical or computational content cannot be used for this requirement. Students must consult with an SCS undergraduate advisor about any course to be used for the Science and Engineering requirement before registration.

<table>
<thead>
<tr>
<th>Category 1A: Cognitive Studies</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Category 3</th>
<th>Category 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>with Category 1A: Cognitive Studies which is a subset of Category</td>
<td>19-608 Privacy Policy, Law, and Technology</td>
<td>24-201 Introduction to Scientific Computing</td>
<td>24-302 Numerical Methods</td>
<td>27-410 Computational Techniques in Engineering</td>
</tr>
<tr>
<td>33-100 Basic Experimental Physics</td>
<td>33-115 Physics for Future Presidents</td>
<td>33-124 Introduction to Astronomy</td>
<td>33-232 Mathematical Methods of Physics</td>
<td>42-201 Professional Issues in Biomedical Engineering</td>
</tr>
<tr>
<td>88-120 Reason, Passion and Cognition</td>
<td>88-230 Human Intelligence and Human Stupidity</td>
<td>Category 1A (for Artificial Intelligence majors): Cognitive Studies - this requirement explores how the brain and the mind work.</td>
<td>85-211 Cognitive Psychology</td>
<td>85-213 Human Information Processing and Artificial Intelligence</td>
</tr>
<tr>
<td>85-370 Perception</td>
<td>85-408 Visual Cognition</td>
<td>Category 2 (all SCS majors): Economic, Political and Social Institutions - this requirement explores the processes by which institutions organize individual preferences and actions into collective outcomes.</td>
<td>85-421 Language and Thought</td>
<td>85-370 Perception</td>
</tr>
<tr>
<td>85-408 Visual Cognition</td>
<td>85-421 Language and Thought</td>
<td>Category 3 (all SCS majors): Cultural Analysis - this requirement seeks to recognize cultures that have shaped and continue to shape the human experience; courses in this category are usually either broad in place, time, or cultural diversity.</td>
<td>85-421 Language and Thought</td>
<td>85-370 Perception</td>
</tr>
</tbody>
</table>

Humanities and Arts
All candidates for a B.S. degree in the School of Computer Science must complete a minimum of 63 units offered by the College of Humanities & Social Sciences and/or the College of Fine Arts as prescribed below. Students pursuing a Bachelor's in Computer Science and Art (http:// coursecatalog.web.cmu.edu/servicesandoptions/intercollegenew/ bxcurscoursedescriptions) should consult the general education requirements for that program.

### A. Freshman Writing Requirement (9 units)
Complete one of the following writing options for 9 units:
- 76-101 Interpretation and Argument (by invitation only)
- 76-102 Advanced First Year Writing: Special Topics

or two of these three writing minis for 9 units total:
- 76-106 Writing about Literature, Art and Culture
- 76-107 Writing about Data
- 76-108 Writing about Public Problems

### B. Breadth Requirement (minimum 27 units: 9 units each)
Complete three courses, one each from Category 1, Category 2, and Category 3. Students may use two minis totaling 9 units or more to satisfy one of the categories, with permission of the Associate Dean for Undergraduate Education, if the minis meet the goals of the desired category. **NOTE: Artificial Intelligence majors replace Category 1 with Category 1A: Cognitive Studies which is a subset of Category 1.**

Category 1 (for all SCS majors except Artificial Intelligence): Cognition, Choice and Behavior - this requirement explores the process of thinking, decision making, and behavior in the context of the individual.
- 70-311 Organizational Behavior
- 80-101 Dangerous Ideas in Science and Society
- 80-130 Introduction to Ethics
- 80-150 Nature of Reason
- 80-180 Nature of Language
- 80-221 Philosophy of Social Science
- 80-241 Ethical Judgments in Professional Life
- 80-242 Conflict and Dispute Resolution
- 80-270 Problems of Mind and Body: Meaning and Doing
- 80-271 Mind and Body: The Objective and the Subjective
- 80-275 Metaphysics
- 80-281 Language and Thought
- 80-330 Ethical Theory
- 85-102 Introduction to Psychology
- 85-211 Cognitive Psychology
- 85-213 Human Information Processing and Artificial Intelligence
- 85-221 Principles of Child Development
- 85-241 Social Psychology
- 85-251 Personality

Category 2 (all SCS majors): Economic, Political and Social Institutions - this requirement explores the processes by which institutions organize individual preferences and actions into collective outcomes.
- 19-101 Introduction to Engineering and Public Policy
- 36-303 Sampling, Survey and Society
- 70-332 Business, Society and Ethics
- 70-364 Business Law
- 73-102 Principles of Microeconomics
- 73-103 Principles of Macroeconomics
- 79-189 History of Democracy: Thinking Beyond the Self
- 79-244 Women in American History
- 79-245 Capitalism and Individualism in American Culture
- 79-299 From Newton to the Nuclear Bomb: History of Science, 1750-1950
- 79-300 History of American Public Policy
- 79-310 U. S. Business History: 1870 to the Present
- 79-320 Women, Politics, and Protest
- 79-321 Documenting Human Rights
- 79-331 Body Politics: Women and Health in America
- 79-341 The Cold War in Documents and Film
- 79-383 The History of Capitalism
- 80-135 Introduction to Political Philosophy
- 80-136 Social Structure, Public Policy & Ethics
- 80-243 Ethics of Leadership
- 80-244 Environmental Ethics
- 80-245 Medical Ethics
- 80-324 Philosophy of Economics
- 80-335 Social and Political Philosophy
- 80-341 Computers, Society and Ethics
- 84-104 Decision Processes in American Political Institutions
- 84-275 Comparative Politics
- 84-310 International Political Economy
- 84-322 Nonviolent Conflict and Revolution
- 84-324 The Future of Democracy
- 84-326 Theories of International Relations
- 84-352 Representation and Redistricting
- 84-362 Diplomacy and Statecraft
- 84-380 US Grand Strategy
- 84-386 The Privatization of Force
- 84-389 Terrorism and Insurgency
- 84-390 Social Media, Technology, and Conflict
- 84-402 Judicial Politics and Behavior
- 84-405 The Future of Warfare
- 84-414 International and Subnational Security
- 88-284 Topics of Law: The Bill of Rights

Category 3 (all SCS majors): Cultural Analysis - this requirement seeks to recognize cultures that have shaped and continue to shape the human experience; courses in this category are usually either broad in place, time, or cultural diversity.
- 48-240 Historical Survey of World Architecture and Urbanism I
- 57-173 Survey of Western Music History
- 60-105 Critical Theory in Art I
C. Humanities and Arts Electives (minimum 27 units)
Complete 3 non-technical courses of at least 9 units each from any of the departments in the Dietrich College of Humanities & Social Sciences or the College of Fine Arts. Some of the courses taught in these units are considered technical courses and may not be used to satisfy this requirement (see Deletions below). Additionally, a select set of courses from Business Administration and from Environmental and Public Policy can also count for this requirement (see Additions below). Students may combine humanities/arts courses with lower units together to form a single course of 9 units or more. Students are encouraged, but not required, to take courses from different departments to gain additional breadth and to create new opportunities for engagement with the university community.

Deletions
Some courses from the Dietrich College or the College of Fine Arts may not count toward the unconstrained electives in Humanities and Arts in SCS due to the technical (computing and/or mathematical) nature of the courses. Courses from the following departments do not count toward the unconstrained Humanities and Arts electives:

- Statistics and Data Science (36), except 36-303 Sampling, Survey and Society
- Information Systems (67)
- Economics (73), except 73-102 Principles of Microeconomics and 73-103 Principles of Macroeconomics

Additionally, the following courses do not count toward the unconstrained Humanities and Arts electives:

- 51-257 Introduction to Computing for Creative Practices 10
- 51-327 Design Center: Introduction to Web Design 9
- 51-328 Design Center: Design for Digital Systems 9
- 76-388 Coding for Humanists 9
- 76-481 Introduction to Multimedia Design 12
- 76-487 Web Design 12
- 80-110 Nature of Mathematical Reasoning 9
- 80-210 Logic and Proofs 9
- 80-211 Logic and Mathematical Inquiry 9
- 80-212 Arguments and Logical Analysis 9
- 80-222 Measurement and Methodology 9
- 80-223 Causality and Probability 9
- 80-305 Decision Theory 9
- 80-310 Formal Logic 9
- 80-311 Undecidability and Incompleteness 9
- 80-314 Causal Discovery, Statistics, and Machine Learning 9
- 80-315 Modal Logic 9
- 80-316 Logic and AI 9
- 80-317 Introduction to Ramsey Theory 6
- 80-405 Game Theory 9
- 80-411 Proof Theory 9
- 80-413 Category Theory 9
- 80-419 Interactive Theorem Proving 9
- 85-219 Biological Foundations of Behavior 9
- 85-310 Research Methods in Cognitive Psychology 9
- 85-314 Cognitive Neuroscience Research Methods 9
- 85-414 Cognitive Neuropsychology 9
- 85-426 Learning in Humans and Machines 9
- 88-251 Empirical Research Methods 9
- 88-372 Social and Emotional Brain 9

Additions
The following courses outside of Dietrich College and the College of Fine Arts may count toward the unconstrained Humanities and Arts electives:

- 16-161 ROB Freshman Seminar: Artificial Intelligence and Humanity 9
- 16-397 Art, Conflict and Technology 12
- 17-333 Privacy Policy, Law, and Technology 9
- 17-562 Law of Computer Technology 9
- 19-101 Introduction to Engineering and Public Policy 12
- 19-351 Applied Methods for Technology-Policy Analysis 9
- 19-402 Telecommunications Technology and Policy for the Internet Age 12
- 32-201 Leadership & Management 9
- 32-402 Leadership and Ethics 9
Honors Research Thesis

Students considering going on to graduate school in Computer Science or related disciplines should take a wide variety of Computer Science and Mathematics courses, as well as consider getting involved in independent research as early as possible. This would be no later than the junior year and can begin even earlier. Students interested in graduate school in computer science or its related areas are strongly encouraged to participate in the SCS Honors Undergraduate Research Thesis program. Additionally, graduate CS courses can be taken with permission of the instructor and in consultation with an academic advisor.

The goal of the SCS Honors Undergraduate Research Thesis Program is to introduce students to the breadth of tasks involved in independent research, including library work, problem formulation, experimentation, analysis, technical writing and public speaking. In particular, students write a paper summarizing prior results and current progress in their desired area of research, present a public poster session in December of their senior year describing their current progress, present their final results with a poster and an oral presentation in the year-end university-wide Undergraduate Research Symposium (Meeting of the Minds) and submit a written thesis at the end of their senior year. Students work closely with faculty researchers to plan and carry out their research. The SCS Honors Undergraduate Research Thesis (70-599) typically starts in the fall semester of the senior year, and spans the entire senior year. Students receive a total of 36 units of academic credit for the thesis work, 18 units per semester. Students should prepare their research prospectus (i.e. proposal of work) during the spring semester of their junior year, and students in this program are advised to plan their schedules carefully to ensure there is ample time to perform the required research for the thesis during the senior year.

Students interested in research are urged to consult with their undergraduate advisor and the SCS Associate Dean no later than the end of their sophomore year in order to plan their workload effectively. Although there is no specific GPA requirement to participate, students are expected to have at least a 3.5 GPA in the core SCS topics relevant to their proposed research to be successful in their work. For those students with no background in research, they may consider using Research and Innovation in Computer Science (07-300, 9 units) as an introduction to the research process in their junior year since this course will introduce students to various research projects going on in the School of Computer Science and important skills that are needed to be an effective researcher. This course leads to a subsequent research practicum (07-400) that allows students to complete a small-scale research study or experiment and present a research poster. Students who use 07-400 to start their senior thesis can use these units toward the required 36 units. Students should consult with their academic advisor concerning how the units earned toward the senior thesis can be used toward elective requirements for their major.

Interested juniors should submit a project prospectus of no more than three pages by the end of their junior year, although submissions over the summer prior to the senior year will also be considered for review. A prospectus must include:

- The name of the research advisor (an SCS faculty member)
- A short abstract (two paragraphs, max)
- A description of the problem to be worked on and its significance
- A tactical description of the proposed research plan, including:
  - a description of the background reading to be carried out,
  - a description of the research contribution,
  - a description of the expected results of the research, and
  - a reasonably detailed timeline for the thesis work
- A bibliography of related work (all references belong here)
- The signature of the research advisor, signifying endorsement of the project and willingness to supervise and evaluate it (or an email confirmation from the research advisor)

Students who need help finding potential advisors should get in touch with their academic advisor or the Associate Dean for Undergraduate Education. Applications to the program are due by the start of the senior year, although submission of applications in the junior year is encouraged. Students completing an outstanding senior thesis based on the judgement of the SCS Undergraduate Review Committee will earn SCS College Honors and can compete for various SCS research awards given out during commencement.

Faculty

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