COMPUTER SCIENCE UNDERGRADUATE MAJOR

See the "Department of Computer Science (http://exploredegrees.stanford.edu/schoolofengineering/computerscience)" section of this bulletin for additional information on the department, and its programs and faculty.

The department offers a B.S. as well as a minor in Computer Science.

Computer Science (CS)

Completion of the undergraduate program in Computer Science leads to the conferral of the Bachelor of Science in Computer Science.

Mission of the Undergraduate Program in Computer Science

The mission of the undergraduate program in Computer Science is to develop students' breadth of knowledge across the subject areas of computer science, including their ability to apply the defining processes of computer science theory, abstraction, design, and implementation to solve problems in the discipline. Students take a set of core courses. After learning the essential programming techniques and the mathematical foundations of computer science, students take courses in areas such as programming techniques, automata and complexity theory, systems programming, computer architecture, analysis of algorithms, artificial intelligence, and applications. The program prepares students for careers in government, law, the corporate sector, and for graduate study.

Requirements

Mathematics (26 units minimum)—

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 103</td>
<td>Mathematical Foundations of Computing</td>
<td>5</td>
</tr>
<tr>
<td>CS 109</td>
<td>Introduction to Probability for Computer Scientists</td>
<td>5</td>
</tr>
<tr>
<td>MATH 19</td>
<td>Calculus</td>
<td>3</td>
</tr>
<tr>
<td>MATH 20</td>
<td>Calculus</td>
<td>3</td>
</tr>
<tr>
<td>MATH 21</td>
<td>Calculus</td>
<td>4</td>
</tr>
</tbody>
</table>

Science elective

Mathematics (11 units minimum)—

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 41</td>
<td>Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 41E</td>
<td>Mechanics, Concepts, Calculations, and Context</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 43</td>
<td>Electricity and Magnetism</td>
<td>4</td>
</tr>
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</table>

Science elective

Technology in Society (3-5 units)—

One course; course chosen must be on the SoE Approved Courses list at <ughb.stanford.edu> the year taken; see Basic Requirements 4 in the School of Engineering section.

Engineering Fundamentals (13 units minimum; see Basic Requirement 3 in the School of Engineering section)—

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>CS 106B</td>
<td>Programming Abstractions</td>
<td>5</td>
</tr>
<tr>
<td>or CS 106X</td>
<td>Programming Abstractions (Accelerated)</td>
<td></td>
</tr>
<tr>
<td>ENGR 40M</td>
<td>An Intro to Making: What is EE (or ENGR 40A and ENGR 40B)</td>
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Computer Science Core (15 units)—

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<tr>
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<tbody>
<tr>
<td>CS 107</td>
<td>Computer Organization and Systems</td>
<td>5</td>
</tr>
<tr>
<td>or CS 107E</td>
<td>Computer Systems from the Ground Up</td>
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</tr>
<tr>
<td>CS 110</td>
<td>Principles of Computer Systems</td>
<td>5</td>
</tr>
<tr>
<td>CS 161</td>
<td>Design and Analysis of Algorithms</td>
<td>5</td>
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Senior Project (3 units)—

<table>
<thead>
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<th>Title</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>CS 191</td>
<td>Senior Project</td>
<td></td>
</tr>
<tr>
<td>CS 191W</td>
<td>Writing Intensive Senior Project</td>
<td></td>
</tr>
<tr>
<td>CS 194</td>
<td>Software Project</td>
<td></td>
</tr>
<tr>
<td>CS 194H</td>
<td>User Interface Design Project</td>
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</tr>
<tr>
<td>CS 210B</td>
<td>Software Project Experience with Corporate Partners</td>
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</tr>
<tr>
<td>CS 294W</td>
<td>Writing Intensive Research Project in Computer Science</td>
<td></td>
</tr>
</tbody>
</table>

Computer Science Depth B.S.

Choose one of the following ten CS degree tracks (a track must consist of at least 25 units and 7 classes):

Artificial Intelligence Track—

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 221</td>
<td>Artificial Intelligence: Principles and Techniques</td>
<td>4</td>
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</table>

Select two courses, each from a different area:

Area I, AI Methods:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>CS 228</td>
<td>Probabilistic Graphical Models: Principles and Techniques</td>
<td></td>
</tr>
<tr>
<td>CS 229</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>CS 234</td>
<td>Reinforcement Learning</td>
<td></td>
</tr>
<tr>
<td>CS 238</td>
<td>Decision Making under Uncertainty</td>
<td></td>
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</table>

Area II, Natural Language Processing:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>CS 124</td>
<td>From Languages to Information</td>
<td></td>
</tr>
<tr>
<td>CS 224N</td>
<td>Natural Language Processing with Deep Learning</td>
<td></td>
</tr>
<tr>
<td>CS 224S</td>
<td>Spoken Language Processing</td>
<td></td>
</tr>
<tr>
<td>CS 224U</td>
<td>Natural Language Understanding</td>
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</table>

Area III, Vision:
### Computer Science Undergraduate Major

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>CS 131</td>
<td>Computer Vision: Foundations and Applications</td>
</tr>
<tr>
<td>CS 231A</td>
<td>Computer Vision: From 3D Reconstruction to Recognition</td>
</tr>
<tr>
<td>CS 231N</td>
<td>Convolutional Neural Networks for Visual Recognition</td>
</tr>
</tbody>
</table>

Area IV, Robotics:
- CS 223A Introduction to Robotics

Select one additional course from the Areas above or from the following:

**AI Methods:**
- CS 157 Computational Logic
- CS 205L Continuous Mathematical Methods with an Emphasis on Machine Learning
- CS 230 Deep Learning
- CS 236 Deep Generative Models
- STATS 315A Modern Applied Statistics: Learning
- STATS 315B Modern Applied Statistics: Data Mining

**Vision:**
- CS 231B
- CS 231M
- CS 331A

**Comp Bio:**
- CS 262
- CS 279 Computational Biology: Structure and Organization of Biomolecules and Cells
- CS 371 Computational Biology in Four Dimensions
- CS 374

**Information and the Web:**
- CS 276 Information Retrieval and Web Search
- CS 224W Analysis of Networks

**Other:**
- CS 151 Logic Programming
- CS 227B General Game Playing
- CS 277
- CS 379 Interdisciplinary Topics

**Robotics and Control:**
- CS 327A Advanced Robotic Manipulation
- CS 329 Topics in Artificial Intelligence (with advisor approval)
- ENGR 205 Introduction to Control Design Techniques
- EE 209
- MS&E 251 Introduction to Stochastic Control with Applications
- MS&E 351 Dynamic Programming and Stochastic Control

Track Electives: at least three additional courses selected from the Areas and lists above, general CS electives, or the following:
- CS 238 Decision Making under Uncertainty
- CS 257 Logic and Artificial Intelligence
- CS 275 Translational Bioinformatics
- CS 326 Topics in Advanced Robotic Manipulation
- CS 334A Convex Optimization I
- or EE 364A Convex Optimization I
- CS 428 Computation and Cognition: The Probabilistic Approach
- EE 278 Introduction to Statistical Signal Processing
- EE 364B Convex Optimization II

**ECON 286** Game Theory and Economic Applications
**MS&E 252** Decision Analysis I: Foundations of Decision Analysis
**MS&E 352** Decision Analysis II: Professional Decision Analysis
**MS&E 355** Influence Diagrams and Probabilistics Networks
**PHIL 152** Computability and Logic
**PSYCH 204A** Human Neuroimaging Methods
**PSYCH 204B** Computational Neuroimaging
**PSYCH 209** Neural Network Models of Cognition
**STATS 200** Introduction to Statistical Inference
**STATS 202** Data Mining and Analysis
**STATS 205** Introduction to Nonparametric Statistics

### Biocomputation Track

The Mathematics, Science, and Engineering Fundamentals requirements are non-standard for this track. See Handbook for Undergraduate Engineering Programs for details.

Select one of the following: 3-4
- CS 221 Artificial Intelligence: Principles and Techniques
- CS 228 Probabilistic Graphical Models: Principles and Techniques
- CS 229 Machine Learning
- CS 231A Computer Vision: From 3D Reconstruction to Recognition

Select one of the following: 3-4
- CS 262
- CS 270 Modeling Biomedical Systems: Ontology, Terminology, Problem Solving
- CS 273A The Human Genome Source Code
- CS 274 Representations and Algorithms for Computational Molecular Biology
- CS 275 Translational Bioinformatics
- CS 279 Computational Biology: Structure and Organization of Biomolecules and Cells

One additional course from the lists above or the following: 3-4
- CS 124 From Languages to Information
- CS 145 Data Management and Data Systems
- CS 147 Introduction to Human-Computer Interaction Design
- CS 148 Introduction to Computer Graphics and Imaging
- CS 248 Interactive Computer Graphics

One course selected from the following: 3-4
- CS 108 Object-Oriented Systems Design
- CS 124 From Languages to Information
- CS 131 Computer Vision: Foundations and Applications
- CS 140 Operating Systems and Systems Programming
- or CS 140E Operating systems design and implementation
- CS 141 Introduction to Computer Sound
- CS 142 Web Applications
- CS 143 Compilers
- CS 144 Introduction to Computer Networking
- CS 145 Data Management and Data Systems
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>CS 146</td>
<td>Introduction to Game Design and Development</td>
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<tr>
<td>CS 147</td>
<td>Introduction to Human-Computer Interaction Design</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 148</td>
<td>Introduction to Computer Graphics and Imaging</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 149</td>
<td>Parallel Computing</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 151</td>
<td>Logic Programming</td>
<td>3</td>
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<tr>
<td>CS 154</td>
<td>Introduction to Automata and Complexity Theory</td>
<td>3-4</td>
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<tr>
<td>CS 155</td>
<td>Computer and Network Security</td>
<td>3</td>
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<tr>
<td>CS 157</td>
<td>Computational Logic</td>
<td>3</td>
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<tr>
<td>or PHIL 151</td>
<td>Metalogic</td>
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<tr>
<td>CS 164</td>
<td>Data Structures</td>
<td>3-4</td>
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<tr>
<td>CS 166</td>
<td>The Modern Algorithmic Toolbox</td>
<td>3-4</td>
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<tr>
<td>CS 190</td>
<td>Software Design Studio</td>
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<tr>
<td>CS 195</td>
<td>Supervised Undergraduate Research (4 units max)</td>
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<tr>
<td>CS 205L</td>
<td>Continuous Mathematical Methods with an Emphasis on Machine Learning</td>
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<tr>
<td>CS 205B</td>
<td>Software Project Experience with Corporate Partners</td>
<td>3-4</td>
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<tr>
<td>CS 217</td>
<td>Hardware Accelerators for Machine Learning</td>
<td>3-4</td>
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<tr>
<td>CS 221</td>
<td>Artificial Intelligence: Principles and Techniques</td>
<td>3-4</td>
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<tr>
<td>CS 223A</td>
<td>Introduction to Robotics</td>
<td>3</td>
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<tr>
<td>CS 224N</td>
<td>Natural Language Processing with Deep Learning</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 224S</td>
<td>Spoken Language Processing</td>
<td>2-4</td>
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<tr>
<td>CS 224U</td>
<td>Natural Language Understanding</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 224W</td>
<td>Analysis of Networks</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 225A</td>
<td>Experimental Robotics</td>
<td>3</td>
</tr>
<tr>
<td>CS 227B</td>
<td>General Game Playing</td>
<td>3</td>
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<tr>
<td>CS 228</td>
<td>Probabilistic Graphical Models: Principles and Techniques</td>
<td>3-4</td>
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<tr>
<td>CS 229</td>
<td>Machine Learning</td>
<td>3-4</td>
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<tr>
<td>CS 229T</td>
<td>Statistical Learning Theory</td>
<td>3</td>
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<tr>
<td>CS 230</td>
<td>Deep Learning</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 231A</td>
<td>Computer Vision: From 3D Reconstruction to Recognition</td>
<td>3-4</td>
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<tr>
<td>CS 231B</td>
<td>Convolutional Neural Networks for Visual Recognition</td>
<td>3-4</td>
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<tr>
<td>CS 231M</td>
<td>Digital Image Processing</td>
<td>3</td>
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<tr>
<td>CS 232</td>
<td>Geometric and Topological Data Analysis</td>
<td>3</td>
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<tr>
<td>CS 233</td>
<td>Reinforcement Learning</td>
<td>3</td>
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<tr>
<td>CS 236</td>
<td>Deep Generative Models</td>
<td>3</td>
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<tr>
<td>CS 238</td>
<td>Decision Making under Uncertainty</td>
<td>3-4</td>
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<tr>
<td>CS 240</td>
<td>Advanced Topics in Operating Systems</td>
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<tr>
<td>CS 242</td>
<td>Programming Languages</td>
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<tr>
<td>CS 243</td>
<td>Program Analysis and Optimizations</td>
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</tr>
<tr>
<td>CS 244</td>
<td>Advanced Topics in Networking</td>
<td>3-4</td>
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<tr>
<td>CS 244B</td>
<td>Distributed Systems</td>
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<tr>
<td>CS 245</td>
<td>Principles of Data-Intensive Systems</td>
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</tr>
<tr>
<td>CS 246</td>
<td>Mining Massive Data Sets</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 247</td>
<td>Human-Computer Interaction Design Studio</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 248</td>
<td>Interactive Computer Graphics</td>
<td>3-4</td>
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<tr>
<td>CS 251</td>
<td>Cryptocurrencies and blockchain technologies</td>
<td>3</td>
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<tr>
<td>CS 252</td>
<td>Analysis of Boolean Functions</td>
<td>3</td>
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<tr>
<td>CS 254</td>
<td>Computational Complexity</td>
<td>3</td>
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<tr>
<td>CS 255</td>
<td>Introduction to Cryptography</td>
<td>3</td>
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<tr>
<td>CS 261</td>
<td>Optimization and Algorithmic Paradigms</td>
<td>3</td>
</tr>
<tr>
<td>CS 262</td>
<td>Algorithms for Modern Data Models</td>
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</tr>
<tr>
<td>CS 266</td>
<td>Beyond Worst-Case Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CS 267</td>
<td>Randomized Algorithms and Probabilistic Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CS 269I</td>
<td>Incentives in Computer Science</td>
<td>3</td>
</tr>
<tr>
<td>CS 270</td>
<td>Modeling Biomedical Systems: Ontology, Terminology, Problem Solving</td>
<td>3</td>
</tr>
<tr>
<td>CS 272</td>
<td>Introduction to Biomedical Informatics Research Methodology</td>
<td>3-5</td>
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<tr>
<td>CS 273A</td>
<td>The Human Genome Source Code</td>
<td>3</td>
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<tr>
<td>CS 273B</td>
<td>Deep Learning in Genomics and Biomedicine</td>
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<tr>
<td>CS 274</td>
<td>Representations and Algorithms for Computational Molecular Biology</td>
<td>3-4</td>
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<tr>
<td>CS 275</td>
<td>Translational Bioinformatics</td>
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<tr>
<td>CS 276</td>
<td>Information Retrieval and Web Search</td>
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<tr>
<td>CS 278</td>
<td>Social Computing</td>
<td>3</td>
</tr>
<tr>
<td>CS 279</td>
<td>Computational Biology: Structure and Organization of Biomolecules and Cells</td>
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<tr>
<td>CS 348B</td>
<td>Computer Graphics: Image Synthesis Techniques</td>
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<tr>
<td>CS 348C</td>
<td>Computer Graphics: Animation and Simulation</td>
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<td>CS 348K</td>
<td>Visual Computing Systems</td>
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<tr>
<td>CS 371</td>
<td>Computational Biology in Four Dimensions</td>
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<tr>
<td>CS 374</td>
<td>Artificial Intelligence: Principles and Techniques</td>
<td>3-4</td>
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<td>CME 108</td>
<td>Introduction to Scientific Computing</td>
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<tr>
<td>EE 180</td>
<td>Digital Systems Architecture</td>
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<tr>
<td>EE 263</td>
<td>Introduction to Linear Dynamical Systems</td>
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<tr>
<td>EE 282</td>
<td>Computer Systems Architecture</td>
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<tr>
<td>EE 364A</td>
<td>Convex Optimization I</td>
<td>3</td>
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<tr>
<td>BIOE 101</td>
<td>Systems Biology</td>
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<tr>
<td>MS&amp;E 152</td>
<td>Introduction to Decision Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>MS&amp;E 252</td>
<td>Decision Analysis I: Foundations of Decision Analysis</td>
<td>3-4</td>
</tr>
<tr>
<td>STATS 206</td>
<td>Applied Multivariate Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315A</td>
<td>Modern Applied Statistics: Learning</td>
<td>2-3</td>
</tr>
<tr>
<td>STATS 315B</td>
<td>Modern Applied Statistics: Data Mining</td>
<td>2-3</td>
</tr>
<tr>
<td>GENE 211</td>
<td>Genomics</td>
<td>3</td>
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<tr>
<td>One course from the following:</td>
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<tr>
<td>CS 145</td>
<td>Data Management and Data Systems</td>
<td>3-4</td>
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<tr>
<td>CS 147</td>
<td>Introduction to Human-Computer Interaction Design</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 221</td>
<td>Artificial Intelligence: Principles and Techniques</td>
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<tr>
<td>Course Code</td>
<td>Course Title</td>
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<tr>
<td>CS 228</td>
<td>Probabilistic Graphical Models: Principles and Techniques</td>
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<td>CS 229</td>
<td>Machine Learning</td>
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<td>CS 262</td>
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<tr>
<td>CS 270</td>
<td>Modeling Biomedical Systems: Ontology, Terminology, Problem Solving</td>
<td>3</td>
</tr>
<tr>
<td>CS 273A</td>
<td>The Human Genome Source Code</td>
<td>3</td>
</tr>
<tr>
<td>CS 273B</td>
<td>Deep Learning in Genomics and Biomedicine</td>
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</tr>
<tr>
<td>CS 274</td>
<td>Representations and Algorithms for Computational Molecular Biology</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 275</td>
<td>Translational Bioinformatics</td>
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<tr>
<td>CS 279</td>
<td>Computational Biology: Structure and Organization of Biomolecules and Cells</td>
<td>3</td>
</tr>
<tr>
<td>CS 371</td>
<td>Computational Biology in Four Dimensions</td>
<td>3</td>
</tr>
<tr>
<td>CS 373</td>
<td>Statistical and Machine Learning Methods for Genomics</td>
<td>3</td>
</tr>
<tr>
<td>CS 374</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE 263</td>
<td>Introduction to Linear Dynamical Systems</td>
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</tr>
<tr>
<td>EE 364A</td>
<td>Convex Optimization I</td>
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<td>STATS 315A</td>
<td>Modern Applied Statistics: Learning</td>
<td>2-3</td>
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<tr>
<td>STATS 315B</td>
<td>Modern Applied Statistics: Data Mining</td>
<td>2-3</td>
</tr>
<tr>
<td>GENE 211</td>
<td>Genomics</td>
<td>3</td>
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<td></td>
<td>One course selected from the list above or the following:</td>
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<tr>
<td>CHEMENG 150</td>
<td>Biochemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEMENG 174</td>
<td>Environmental Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>APPPHYS 294</td>
<td>Cellular Biophysics</td>
<td>3</td>
</tr>
<tr>
<td>BIO 104</td>
<td>Advance Molecular Biology: Epigenetics and Proteostasis</td>
<td>5</td>
</tr>
<tr>
<td>BIO 112</td>
<td>Human Physiology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 118</td>
<td>Developmental Neurobiology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 158</td>
<td>Theoretical Population Genetics</td>
<td>3</td>
</tr>
<tr>
<td>BIO 183</td>
<td>Theoretical Population Genetics</td>
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<tr>
<td>BIO 188</td>
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<tr>
<td>BIO 189</td>
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</tr>
<tr>
<td>BIO 214</td>
<td>Advanced Cell Biology</td>
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</tr>
<tr>
<td>BIO 217</td>
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</tr>
<tr>
<td>BIO 230</td>
<td>Molecular and Cellular Immunology</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 141</td>
<td>The Chemical Principles of Life</td>
<td>4</td>
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<tr>
<td>CHEM 171</td>
<td>Physical Chemistry I</td>
<td>4</td>
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<tr>
<td>BIOC 218</td>
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<tr>
<td>BIOC 241</td>
<td>Biological Macromolecules</td>
<td>3-5</td>
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<tr>
<td></td>
<td>One course from the following:</td>
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<tr>
<td>BIOE 220</td>
<td>Introduction to Imaging and Image-based Human Anatomy</td>
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<tr>
<td>CHEMENG 150</td>
<td>Biochemical Engineering</td>
<td>3</td>
</tr>
<tr>
<td>CHEMENG 174</td>
<td>Environmental Microbiology</td>
<td>3</td>
</tr>
<tr>
<td>CS 262</td>
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<tr>
<td>CS 274</td>
<td>Representations and Algorithms for Computational Molecular Biology</td>
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<tr>
<td>CS 279</td>
<td>Computational Biology: Structure and Organization of Biomolecules and Cells</td>
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<tr>
<td>CS 371</td>
<td>Computational Biology in Four Dimensions</td>
<td>3</td>
</tr>
<tr>
<td>CS 374</td>
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<tr>
<td>ME 281</td>
<td>Biomechanics of Movement</td>
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<tr>
<td>APPPHYS 294</td>
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<tr>
<td>BIO 104</td>
<td>Advance Molecular Biology: Epigenetics and Proteostasis</td>
<td>5</td>
</tr>
<tr>
<td>BIO 112</td>
<td>Human Physiology</td>
<td>4</td>
</tr>
<tr>
<td>BIO 118</td>
<td>Developmental Neurobiology</td>
<td>4</td>
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<tr>
<td>BIO 158</td>
<td>Theoretical Population Genetics</td>
<td>3</td>
</tr>
<tr>
<td>BIO 183</td>
<td>Theoretical Population Genetics</td>
<td>3</td>
</tr>
<tr>
<td>BIO 188</td>
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<td>BIO 214</td>
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<tr>
<td>BIO 217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO 230</td>
<td>Molecular and Cellular Immunology</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 171</td>
<td>Physical Chemistry I</td>
<td>4</td>
</tr>
<tr>
<td>BIOC 218</td>
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<tr>
<td>BIOC 241</td>
<td>Biological Macromolecules</td>
<td>3-5</td>
</tr>
<tr>
<td>DBIO 210</td>
<td>Developmental Biology</td>
<td>4</td>
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<tr>
<td>GENE 211</td>
<td>Genomics</td>
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<tr>
<td>SURG 101</td>
<td>Regional Study of Human Structure</td>
<td>5</td>
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**Computer Engineering Track**

For this track there is a 10 unit minimum for ENGR Fundamentals and a 29 unit minimum for Depth (for track and elective courses)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>EE 108</td>
<td>Digital System Design</td>
<td>6</td>
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<tr>
<td>&amp; EE 180</td>
<td>Digital Systems Architecture</td>
<td>8</td>
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<td>Select two of the following:</td>
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<tr>
<td>EE 101A</td>
<td>Circuits I</td>
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<tr>
<td>EE 101B</td>
<td>Circuits II</td>
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</tr>
<tr>
<td>EE 102A</td>
<td>Signal Processing and Linear Systems</td>
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<tr>
<td>EE 102B</td>
<td>Signal Processing and Linear Systems</td>
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<tr>
<td>Satisfy the requirements of one of the following concentrations:</td>
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<tr>
<td>1) Digital Systems Concentration</td>
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<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming</td>
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</tr>
<tr>
<td>or CS 140E</td>
<td>Operating Systems and Systems Programming (if not counted above)</td>
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<tr>
<td>EE 109</td>
<td>Digital Systems Design Lab</td>
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<tr>
<td>EE 271</td>
<td>Introduction to VLSI Systems</td>
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<td>Plus two of the following (6-8 units):</td>
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<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming</td>
<td></td>
</tr>
<tr>
<td>or CS 140E</td>
<td>Operating Systems and Systems Programming (if not counted above)</td>
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</tr>
<tr>
<td>CS 144</td>
<td>Introduction to Computer Networking</td>
<td></td>
</tr>
<tr>
<td>CS 149</td>
<td>Parallel Computing</td>
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<tr>
<td>CS 190</td>
<td>Software Design Studio</td>
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<tr>
<td>CS 217</td>
<td>Hardware Accelerators for Machine Learning</td>
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<tr>
<td>CS 240E</td>
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<td></td>
</tr>
<tr>
<td>CS 244</td>
<td>Advanced Topics in Networking</td>
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</tr>
<tr>
<td>EE 273</td>
<td>Digital Systems Engineering</td>
<td></td>
</tr>
<tr>
<td>EE 282</td>
<td>Computer Systems Architecture</td>
<td></td>
</tr>
<tr>
<td>2) Robotics and Mechatronics Concentration</td>
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<tr>
<td>CS 205L</td>
<td>Continuous Mathematical Methods with an Emphasis on Machine Learning</td>
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<tr>
<td>CS 223A</td>
<td>Introduction to Robotics</td>
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<tr>
<td>ME 210</td>
<td>Introduction to Mechatronics</td>
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<tr>
<td>ENGR 105</td>
<td>Feedback Control Design</td>
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<tr>
<td>Plus one of the following (3-4 units):</td>
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<tr>
<td>CS 225A</td>
<td>Experimental Robotics</td>
<td></td>
</tr>
<tr>
<td>CS 231A</td>
<td>Computer Vision: From 3D Reconstruction to Recognition</td>
<td></td>
</tr>
<tr>
<td>ENGR 205</td>
<td>Introduction to Control Design Techniques</td>
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</table>
ENGR 207B  Linear Control Systems II

3) Networking Concentration

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<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming and Introduction to Computer Networking (CS 140E can substitute for CS 140)</td>
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<tr>
<td>&amp; CS 144</td>
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Plus three of the following (9-11 units):

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<th>Title</th>
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<tbody>
<tr>
<td>CS 240</td>
<td>Advanced Topics in Operating Systems</td>
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<tr>
<td>CS 241</td>
<td>Embedded Systems Workshop</td>
</tr>
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<td>CS 244</td>
<td>Advanced Topics in Networking</td>
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<tr>
<td>CS 244B</td>
<td>Distributed Systems</td>
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<tr>
<td>EE 179</td>
<td>Analog and Digital Communication Systems</td>
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**Graphics Track—**

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<tbody>
<tr>
<td>CS 148</td>
<td>Introduction to Computer Graphics and Imaging and Interactive Computer Graphics</td>
</tr>
<tr>
<td>&amp; CS 248</td>
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Select one of the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CS 205L</td>
<td>Continuous Mathematical Methods with an Emphasis on Machine Learning</td>
</tr>
<tr>
<td>CME 104</td>
<td>Linear Algebra and Partial Differential Equations for Engineers (Note: students taking CME 104 are also required to take its prerequisite course, CME 102)</td>
</tr>
<tr>
<td>CME 108</td>
<td>Introduction to Scientific Computing</td>
</tr>
<tr>
<td>MATH 52</td>
<td>Integral Calculus of Several Variables</td>
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<tr>
<td>MATH 113</td>
<td>Linear Algebra and Matrix Theory</td>
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</table>

Select two of the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CS 146</td>
<td>Introduction to Game Design and Development</td>
</tr>
<tr>
<td>CS 231A</td>
<td>Computer Vision: From 3D Reconstruction to Recognition</td>
</tr>
<tr>
<td>or CS 131</td>
<td>Computer Vision: Foundations and Applications</td>
</tr>
<tr>
<td>CS 233</td>
<td>Geometric and Topological Data Analysis</td>
</tr>
<tr>
<td>CS 268</td>
<td>Geometric Algorithms</td>
</tr>
<tr>
<td>CS 348B</td>
<td>Computer Graphics: Image Synthesis Techniques</td>
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<tr>
<td>CS 348C</td>
<td>Computer Graphics: Animation and Simulation</td>
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<tr>
<td>CS 348K</td>
<td>Visual Computing Systems</td>
</tr>
<tr>
<td>CS 448</td>
<td>Topics in Computer Graphics</td>
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</table>

**Track Electives:** at least two additional courses from the lists above, the general CS electives list, or the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>ARTSTUDI 160</td>
<td>Intro to Digital / Physical Design</td>
</tr>
<tr>
<td>ARTSTUDI 170</td>
<td>Photography I: Black and White</td>
</tr>
<tr>
<td>ARTSTUDI 179</td>
<td>Digital Art I</td>
</tr>
<tr>
<td>CME 302</td>
<td>Numerical Linear Algebra</td>
</tr>
<tr>
<td>CME 306</td>
<td>Numerical Solution of Partial Differential Equations</td>
</tr>
<tr>
<td>EE 168</td>
<td>Introduction to Digital Image Processing</td>
</tr>
<tr>
<td>EE 262</td>
<td>Two-Dimensional Imaging</td>
</tr>
<tr>
<td>EE 264</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>EE 278</td>
<td>Introduction to Statistical Signal Processing</td>
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<tr>
<td>EE 368</td>
<td>Digital Image Processing</td>
</tr>
<tr>
<td>ME 101</td>
<td>Visual Thinking</td>
</tr>
<tr>
<td>PSYCH 30</td>
<td>Introduction to Perception</td>
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<tr>
<td>PSYCH 221</td>
<td>Image Systems Engineering</td>
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<td>PSYCH 221</td>
<td>Image Systems Engineering</td>
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**Human-Computer Interaction Track—**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>CS 147</td>
<td>Introduction to Human-Computer Interaction Design</td>
</tr>
<tr>
<td>CS 247</td>
<td>Human-Computer Interaction Design Studio</td>
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Any three of the following:

<table>
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<tr>
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<th>Title</th>
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<tbody>
<tr>
<td>CS 142</td>
<td>Web Applications</td>
</tr>
<tr>
<td>CS 146</td>
<td>Introduction to Game Design and Development</td>
</tr>
<tr>
<td>CS 148</td>
<td>Introduction to Computer Graphics and Imaging</td>
</tr>
<tr>
<td>CS 194H</td>
<td>User Interface Design Project</td>
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<tr>
<td>CS 206</td>
<td>Exploring Computational Journalism</td>
</tr>
<tr>
<td>CS 210A</td>
<td>Software Project Experience with Corporate Partners</td>
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<tr>
<td>CS 278</td>
<td>Social Computing</td>
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<tr>
<td>CS 376</td>
<td>Human-Computer Interaction Research</td>
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Any CS 377 Topics in HCI of three or more units

<table>
<thead>
<tr>
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<th>Title</th>
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<tbody>
<tr>
<td>CS 448B</td>
<td>Data Visualization</td>
</tr>
<tr>
<td>ME 216M</td>
<td>Introduction to the Design of Smart Products</td>
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At least two additional courses from above list, the general CS electives list, or the following:  

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>Any d.school class of 3 or more units</td>
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<tr>
<td>Any class of 3 or more units at hci.stanford.edu under the 'courses' link</td>
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**Communication:**

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<tr>
<td>COMM 121</td>
<td>Behavior and Social Media</td>
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<tr>
<td>COMM 124</td>
<td>Lies, Trust, and Tech</td>
</tr>
<tr>
<td>or COMM 224</td>
<td>Lies, Trust, and Tech</td>
</tr>
<tr>
<td>COMM 140</td>
<td>The Politics of Algorithms</td>
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<tr>
<td>or COMM 240</td>
<td>The Politics of Algorithms</td>
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<tr>
<td>COMM 154</td>
<td>Virtual People</td>
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<td>COMM 169</td>
<td>Media Psychology</td>
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<td>or COMM 269</td>
<td>Media Psychology</td>
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<tr>
<td>COMM 172</td>
<td>Media Psychology</td>
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<tr>
<td>or COMM 272</td>
<td>Media Psychology</td>
</tr>
<tr>
<td>COMM 182</td>
<td>The Politics of Algorithms</td>
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<td>COMM 254</td>
<td>The Politics of Algorithms</td>
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<td>COMM 324</td>
<td>Language and Technology</td>
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**Art Studio—**

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<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>ARTSTUDI 160</td>
<td>Intro to Digital / Physical Design</td>
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<tr>
<td>ARTSTUDI 162</td>
<td>Embodied Interfaces</td>
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<tr>
<td>ARTSTUDI 163</td>
<td>Drawing with Code</td>
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<tr>
<td>ARTSTUDI 164</td>
<td>DESIGN IN PUBLIC SPACES</td>
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<tr>
<td>ARTSTUDI 165</td>
<td>Social Media and Performative Practices</td>
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<tr>
<td>ARTSTUDI 168</td>
<td>Data as Material</td>
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<tr>
<td>ARTSTUDI 264</td>
<td>Advanced Interaction Design</td>
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<tr>
<td>ARTSTUDI 266</td>
<td>Sculptural Screens / Malleable Media</td>
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<tr>
<td>ARTSTUDI 267</td>
<td>Emerging Technology Studio</td>
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<td>Sym Sys-</td>
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<td>SYMSYS 245</td>
<td>Cognition in Interaction Design</td>
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**Psychology—**
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<th>Course Title</th>
<th>Units</th>
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<tr>
<td>PSYCH 30</td>
<td>Introduction to Perception</td>
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<tr>
<td>PSYCH 35</td>
<td>Minds and Machines</td>
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<tr>
<td>PSYCH 45</td>
<td>Introduction to Learning and Memory</td>
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<tr>
<td>PSYCH 50</td>
<td>Introduction to Cognitive Neuroscience</td>
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<td>PSYCH 60</td>
<td>Introduction to Developmental Psychology</td>
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<td>PSYCH 70</td>
<td>Self and Society: Introduction to Social Psychology</td>
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<td>PSYCH 75</td>
<td>Introduction to Cultural Psychology</td>
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<td>PSYCH 80</td>
<td>Introduction to Personality and Affective Science</td>
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<td>PSYCH 90</td>
<td>Introduction to Clinical Psychology</td>
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<td>PSYCH 95</td>
<td>Introduction to Abnormal Psychology</td>
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<td>PSYCH 131</td>
<td>Judgment and Decision-Making</td>
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<td>PSYCH 154</td>
<td>Empirical Methods: Ethnographic Methods</td>
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<tr>
<td>COMM 314</td>
<td>Introduction to Applied Statistics</td>
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<tr>
<td>PSYCH 251</td>
<td>Experimental Methods</td>
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<td>PSYCH 252</td>
<td>Statistical Methods for Behavioral and Social Sciences</td>
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<td>PSYCH 253</td>
<td>High-Dimensional Methods for Behavioral and Neural Data</td>
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<tr>
<td>STATS 203</td>
<td>Introduction to Regression Models and Analysis of Variance</td>
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<td>EDUC 191</td>
<td>Introduction to Survey Research</td>
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<td>HUMBIO 82A</td>
<td>Qualitative Research Methodology</td>
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<tr>
<td>ME 101</td>
<td>Visual Thinking</td>
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<tr>
<td>ME 115A</td>
<td>Introduction to Human Values in Design</td>
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<tr>
<td>ME 203</td>
<td>Design and Manufacturing</td>
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<tr>
<td>ME 210</td>
<td>Introduction to Mechatronics</td>
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<tr>
<td>ME 216A</td>
<td>Advanced Product Design: Needfinding</td>
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<tr>
<td>EDUC 236</td>
<td>Beyond Bits and Atoms: Designing Technological Tools</td>
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<td>EDUC 281</td>
<td>Technology for Learners</td>
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<tr>
<td>EDUC 239</td>
<td>Educating Young STEM Thinkers</td>
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<td>EDUC 338</td>
<td>Innovations in Education</td>
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<td>EDUC 342</td>
<td>Child Development and New Technologies</td>
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<td>Global Work</td>
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<tr>
<td>MS&amp;E 331</td>
<td>Advanced Product Design: Needfinding</td>
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<td>MUSIC 220A</td>
<td>Fundamentals of Computer-Generated Sound</td>
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<td>MUSIC 220B</td>
<td>Compositional Algorithms, Psychoacoustics, and Computational Music</td>
<td></td>
</tr>
<tr>
<td>MUSIC 220C</td>
<td>Research Seminar in Computer-Generated Music</td>
<td></td>
</tr>
<tr>
<td>MUSIC 250A</td>
<td>Physical Interaction Design for Music</td>
<td></td>
</tr>
<tr>
<td>MUSIC 256A</td>
<td>Music, Computing, Design I: The Art of Design</td>
<td></td>
</tr>
<tr>
<td>Optional Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Information Track—**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 124</td>
<td>From Languages to Information</td>
<td>4</td>
</tr>
<tr>
<td>CS 145</td>
<td>Data Management and Data Systems</td>
<td>4</td>
</tr>
<tr>
<td>Two courses, from different areas:</td>
<td>6-9</td>
<td></td>
</tr>
</tbody>
</table>

1) Information-based AI applications
- CS 224N  | Natural Language Processing with Deep Learning   |
- CS 224S  | Spoken Language Processing                        |
- CS 229   | Machine Learning                                  |
- CS 233   | Geometric and Topological Data Analysis           |
- CS 234   | Reinforcement Learning                            |

2) Database and Information Systems
- CS 140   | Operating Systems and Systems Programming         |
- or CS 140E | Operating systems design and implementation |
- CS 142   | Web Applications                                  |
- CS 151   | Logic Programming                                 |
- CS 245   | Principles of Data-Intensive Systems              |
- CS 246   | Mining Massive Data Sets                          |
- CS 341   | Project in Mining Massive Data Sets               |
- CS 345   | (Offered occasionally)                            |

3) Information Systems in Biology
- CS 262   | Information Retrieval and Web Search             |

At least three additional courses from the above areas or the general CS electives list.

**Systems Track—**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming</td>
<td>4</td>
</tr>
</tbody>
</table>
- or CS 140E | Operating systems design and implementation |
| Select one of the following: | 3-4 |
| CS 143      | Compilers                                        |       |
| EE 180      | Digital Systems Architecture                      |       |

Two additional courses from the list above or the following: | 6-8 |

- CS 144   | Introduction to Computer Networking               |
- CS 145   | Data Management and Data Systems                  |
- CS 149   | Parallel Computing                                |
- CS 155   | Computer and Network Security                     |
- CS 190   | Software Design Studio                            |
- CS 217   | Hardware Accelerators for Machine Learning        |
- CS 240   | Advanced Topics in Operating Systems              |
- CS 242   | Programming Languages                            |
- CS 243   | Program Analysis and Optimizations                |
- CS 244   | Advanced Topics in Networking                     |
- CS 245   | Principles of Data-Intensive Systems              |
- EE 271   | Introduction to VLSI Systems                      |
- EE 282   | Computer Systems Architecture                     |
Track Electives: at least three additional courses selected from the list above, the general CS electives list, or the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 241</td>
<td>Embedded Systems Workshop</td>
</tr>
<tr>
<td>CS 316</td>
<td>Advanced Multi-Core Systems</td>
</tr>
<tr>
<td>CS 341</td>
<td>Project in Mining Massive Data Sets</td>
</tr>
<tr>
<td>CS 343</td>
<td>(Not given this year)</td>
</tr>
<tr>
<td>CS 344</td>
<td>Topics in Computer Networks (3 or more units, any suffix)</td>
</tr>
<tr>
<td>CS 345</td>
<td>(Advanced Topics in Database Systems - 3 or more units, any suffix)</td>
</tr>
<tr>
<td>CS 349</td>
<td>Topics in Programming Systems (with permission of undergraduate advisor)</td>
</tr>
<tr>
<td>CS 448</td>
<td>Topics in Computer Graphics</td>
</tr>
<tr>
<td>EE 108</td>
<td>Digital System Design</td>
</tr>
<tr>
<td>EE 382C</td>
<td>Interconnection Networks</td>
</tr>
<tr>
<td>EE 384A</td>
<td>Internet Routing Protocols and Standards</td>
</tr>
<tr>
<td>EE 384B</td>
<td>Wireless Local and Wide Area Networks</td>
</tr>
<tr>
<td>EE 384C</td>
<td>Performance Engineering of Computer Systems &amp; Networks</td>
</tr>
</tbody>
</table>

**Theory Track—**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 154</td>
<td>Introduction to Automata and Complexity Theory 4</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>CS 168</td>
<td>The Modern Algorithmic Toolbox</td>
</tr>
<tr>
<td>CS 255</td>
<td>Introduction to Cryptography</td>
</tr>
<tr>
<td>CS 261</td>
<td>Optimization and Algorithmic Paradigms</td>
</tr>
<tr>
<td>CS 264</td>
<td>Beyond Worst-Case Analysis</td>
</tr>
<tr>
<td>CS 265</td>
<td>Randomized Algorithms and Probabilistic Analysis</td>
</tr>
<tr>
<td>CS 268</td>
<td>Geometric Algorithms</td>
</tr>
</tbody>
</table>

Two additional courses from the list above or the following: 6-8

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 143</td>
<td>Compilers</td>
</tr>
<tr>
<td>CS 151</td>
<td>Logic Programming</td>
</tr>
<tr>
<td>CS 155</td>
<td>Computer and Network Security</td>
</tr>
<tr>
<td>CS 157</td>
<td>Computational Logic</td>
</tr>
<tr>
<td>or PHIL 151</td>
<td>Metalogic</td>
</tr>
<tr>
<td>CS 166</td>
<td>Data Structures</td>
</tr>
<tr>
<td>CS 205L</td>
<td>Continuous Mathematical Methods with an Emphasis on Machine Learning</td>
</tr>
<tr>
<td>CS 228</td>
<td>Probabilistic Graphical Models: Principles and Techniques</td>
</tr>
<tr>
<td>CS 233</td>
<td>Geometric and Topological Data Analysis</td>
</tr>
<tr>
<td>CS 236</td>
<td>Deep Generative Models</td>
</tr>
<tr>
<td>CS 242</td>
<td>Programming Languages</td>
</tr>
<tr>
<td>CS 250</td>
<td>Algebraic Error Correcting Codes</td>
</tr>
<tr>
<td>CS 251</td>
<td>Cryptocurrencies and blockchain technologies</td>
</tr>
<tr>
<td>CS 252</td>
<td>Analysis of Boolean Functions</td>
</tr>
<tr>
<td>CS 254</td>
<td>Computational Complexity</td>
</tr>
<tr>
<td>CS 259</td>
<td>(with permission of undergraduate advisor)</td>
</tr>
<tr>
<td>CS 262</td>
<td>Algorithms for Modern Data Models</td>
</tr>
<tr>
<td>CS 263</td>
<td>Algorithms for Modern Data Models</td>
</tr>
<tr>
<td>CS 266</td>
<td></td>
</tr>
<tr>
<td>CS 267</td>
<td></td>
</tr>
<tr>
<td>CS 269I</td>
<td>Incentives in Computer Science</td>
</tr>
</tbody>
</table>

**Unspecialized Track—**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 154</td>
<td>Introduction to Automata and Complexity Theory 4</td>
</tr>
<tr>
<td>Select one of the following:</td>
<td></td>
</tr>
<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming</td>
</tr>
<tr>
<td>or CS 140E</td>
<td>Operating systems design and implementation</td>
</tr>
<tr>
<td>CS 143</td>
<td>Compilers</td>
</tr>
</tbody>
</table>

One additional course from the list above or the following: 3-4

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 144</td>
<td>Introduction to Computer Networking</td>
</tr>
<tr>
<td>CS 155</td>
<td>Computer and Network Security</td>
</tr>
<tr>
<td>CS 190</td>
<td>Software Design Studio</td>
</tr>
<tr>
<td>CS 242</td>
<td>Programming Languages</td>
</tr>
<tr>
<td>CS 244</td>
<td>Advanced Topics in Networking</td>
</tr>
<tr>
<td>EE 180</td>
<td>Digital Systems Architecture</td>
</tr>
</tbody>
</table>

Select one of the following: 3-4

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 221</td>
<td>Artificial Intelligence: Principles and Techniques</td>
</tr>
<tr>
<td>CS 223A</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>CS 228</td>
<td>Probabilistic Graphical Models: Principles and Techniques</td>
</tr>
<tr>
<td>CS 229</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>CS 231A</td>
<td>Computer Vision: From 3D Reconstruction to Recognition</td>
</tr>
</tbody>
</table>

Select one of the following: 3-4

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 145</td>
<td>Data Management and Data Systems</td>
</tr>
<tr>
<td>CS 147</td>
<td>Introduction to Human-Computer Interaction Design</td>
</tr>
<tr>
<td>CS 148</td>
<td>Introduction to Computer Graphics and Imaging</td>
</tr>
<tr>
<td>CS 248</td>
<td>Interactive Computer Graphics</td>
</tr>
<tr>
<td>CS 262</td>
<td></td>
</tr>
</tbody>
</table>

At least two courses from the general CS electives list 4

**Individually Designed Track—**

Students may propose an individually designed track. Proposals should include a minimum of 25 units and seven courses, at least four of
which must be CS courses numbered 100 or above. See Handbook for Undergraduate Engineering Programs for further information.

For additional information and sample programs see the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

1 MATH 19, MATH 20, and MATH 21 OR MATH 41 and MATH 42 OR AP Calculus Credit may be used as long as at least 26 MATH units are taken. AP Calculus Credit must be approved by the School of Engineering.

2 The math electives list consists of: MATH 51, MATH 52, MATH 53, MATH 104, MATH 108, MATH 109, MATH 110, MATH 113; CS 157, CS 205L; PHIL 151; CME 100, CME 102, CME 103 (or EE103), CME 104. Restrictions: CS 157 and PHIL 151 may not be used in combination to satisfy the math electives requirements. Students who have taken both MATH 51 and MATH 52 may not count CME 100 as an elective. Courses counted as math electives cannot also count as CS electives, and vice versa.

3 The science elective may be any course of 3 or more units from the School of Engineering Science list (Fig. 4-2 in the UGHB), PSYCH 30, or AP Chemistry Credit. Either of the PHYSICS sequences 61/63 or 21/23 may be substituted for 41/43 as long as at least 11 science units are taken. AP Chemistry Credit and AP Physics Credit must be approved by the School of Engineering.


5 CS 205L is strongly recommended in this list for the Graphics track. Students taking CME 104 Linear Algebra and Partial Differential Equations for Engineers are also required to take its prerequisite, CME 102 Ordinary Differential Equations for Engineers.

6 Independent study projects (CS 191 Senior Project or CS 191W Writing Intensive Senior Project) require faculty sponsorship and must be approved by the adviser, faculty sponsor, and the CS senior project adviser (P. Young). A signed approval form, along with a brief description of the proposed project, should be filed with the project adviser (P. Young). A signed approval form, along with a brief description of the proposed project, should be filed with the project adviser (P. Young). Further details can be found in the Handbook for Undergraduate Engineering Programs (UGHB) (http://ughb.stanford.edu).

7 A course may only be counted towards one requirement; it may not be double-counted. All courses taken for the major must be taken for a letter grade if that option is offered by the instructor. Minimum Combined GPA for all courses in Engineering Fundamentals and Depth is 2.0.

Honors Program in Computer Science

The Department of Computer Science (CS) offers an honors program for undergraduates whose academic records and personal initiative indicate that they have the necessary skills to undertake high-quality research in computer science. Admission to the program is by application only. To apply for the honors program, students must be majoring in Computer Science, have a grade point average (GPA) of at least 3.6 in courses that count toward the major, and achieve senior standing (135 or more units) by the end of the academic year in which they apply. Coterminally master’s students are eligible to apply as long as they have not already received their undergraduate degree. Beyond these requirements, students who apply for the honors program must find a Computer Science faculty member who agrees to serve as the thesis adviser for the project. Thesis advisers must be members of Stanford’s Academic Council.

Students who meet the eligibility requirements and wish to be considered for the honors program must submit a written application to the CS undergraduate program office by May 1 of the year preceding the honors work. The application must include a letter describing the research project, a letter of endorsement from the faculty sponsor, and a transcript of courses taken at Stanford. Each year, a faculty review committee selects the successful candidates for honors from the pool of qualified applicants.

In order to receive departmental honors, students admitted to the honors program must, in addition to satisfying the standard requirements for the undergraduate degree, do the following:

1. Complete at least 9 units of CS 191 or CS 191W under the direction of their project sponsor.
2. Attend a weekly honors seminar Winter and Spring quarters.
3. Complete an honors thesis deemed acceptable by the thesis adviser and at least one additional faculty member.
4. Present the thesis at a public colloquium sponsored by the department.
5. Maintain the 3.6 GPA required for admission to the honors program.

Computer Science (CS) Minor

The following core courses fulfill the minor requirements. Prerequisites include the standard mathematics sequence through MATH 51 (or CME 100).

<table>
<thead>
<tr>
<th>Units</th>
<th>Core:</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>CS 106B Programming Abstractions</td>
</tr>
<tr>
<td>or CS 106X Programming Abstractions (Accelerated)</td>
<td></td>
</tr>
</tbody>
</table>

Introductory Programming (AP Credit may be used to fulfill this requirement):

<table>
<thead>
<tr>
<th>Units</th>
<th>Electives (choose two courses from different areas):</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Artificial Intelligence—</td>
</tr>
<tr>
<td>4</td>
<td>From Languages to Information</td>
</tr>
<tr>
<td>4</td>
<td>Artificial Intelligence: Principles and Techniques</td>
</tr>
<tr>
<td>3-4</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>4</td>
<td>Introduction to Human-Computer Interaction Design</td>
</tr>
</tbody>
</table>

Software—

<table>
<thead>
<tr>
<th>Units</th>
<th>Systems—</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>CS 140 Operating Systems and Systems Programming</td>
</tr>
<tr>
<td>or CS 140E Operating systems design and implementation</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CS 143 Compilers</td>
</tr>
<tr>
<td>4</td>
<td>CS 144 Introduction to Computer Networking</td>
</tr>
<tr>
<td>4</td>
<td>CS 145 Data Management and Data Systems</td>
</tr>
<tr>
<td>4</td>
<td>CS 148 Introduction to Computer Graphics and Imaging</td>
</tr>
</tbody>
</table>

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### Theory—

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 154</td>
<td>Introduction to Automata and Complexity Theory</td>
<td>4</td>
</tr>
<tr>
<td>CS 157</td>
<td>Computational Logic</td>
<td>3</td>
</tr>
<tr>
<td>CS 161</td>
<td>Design and Analysis of Algorithms</td>
<td>5</td>
</tr>
</tbody>
</table>

*Note: for students with no programming background and who begin with CS 106A, the minor consists of seven courses.*