

COMPUTER AND INFORMATION SCIENCE, PHD

The Doctoral Program (Ph.D.) in Computer and Information Science (CIS) welcomes candidates with strong training in any of the disciplines related to modern information processing, with an emphasis on computer science and mathematics. Research and teaching form the essence of our doctoral program. Our curriculum is designed to develop the intellectual skills essential for the rapidly changing character of research and to meet the demands of academe and industry. Students develop their own advanced study focus, working with faculty mentors on topics ranging from the core computer science discipline to diverse scholarly interactions within the School of Engineering and the University.

For more information: <http://www.cis.upenn.edu/prospective-students/graduate/phd.php>

View the University's Academic Rules for PhD Programs (<http://catalog.upenn.edu/pennbook/academic-rules-phd/>).

Required Courses

Code	Title	Course Units
Responsible Conduct of Research Requirement		
EAS 9000	Responsible Conduct for Research (RCR), Engineering	0
Breadth Courses ¹		
Choose two breadth courses, each from a different area among the five buckets: ²		2
Mathematical Foundations:		
CIS 5000	Software Foundations	
CIS 5020	Analysis of Algorithms	
CIS 5110	Theory of Computation	
CIS 5180	Topics in Logic: Finite Model Theory and Descriptive Complexity	
CIS 5200	Machine Learning <small>*also counts in the Learning and Modeling bucket</small>	
CIS 5560	Cryptography	
CIS 6100	Advanced Geometric Methods in Computer Science	
CIS 6250	Theory of Machine Learning	
CIS 6700	Advanced Topics in Programming Languages	
CIS 6730	Computer-Aided Verification	
CIS 6770	Advanced Topics in Algorithms and Complexity	
CIS 6820	Friendly Logics	
System Design and Implementation:		
CIS 5500	Database and Information Systems	
CIS 5550	Internet and Web Systems	
CIS 5710	Computer Organization and Design	
CIS 5010	Computer Architecture	
CIS 5050	Software Systems	
CIS 5400	Principles of Embedded Computation	

CIS 5410	Embedded Software for Life-Critical Applications	
CIS 5420	Embedded Systems Programming	
CIS 5470	Software Analysis	
CIS 5480	Operating Systems Design and Implementation	
CIS 5490	Wireless Communications for Mobile Networks and Internet of Things	
CIS 5510	Computer and Network Security	
CIS 5520	Advanced Programming	
CIS 5530	Networked Systems	
CIS 5540	Programming Paradigms	
CIS 5570	Programming for the Web	
CIS 5650	GPU Programming and Architecture	
CIS 6010	Advanced Topics in Computer Architecture	
CIS 6400	Advanced Topics in Software Systems: Data Driven IoT/Edge Computing	
CIS 6500	Advanced Topics in Databases	

Learning and Modeling:

CIS 5190	Applied Machine Learning	
CIS 5210	Artificial Intelligence	
CIS 5360	Fundamentals of Computational Biology	
CIS 5670	Scientific Computing	
CIS 5220	Deep Learning for Data Science	
CIS 5260	Machine Translation	
CIS 5300	Natural Language Processing	
CIS 5370	Biomedical Image Analysis	
CIS 5800	Machine Perception	
CIS 5810	Computer Vision & Computational Photography	
CIS 6200	Advanced Topics in Machine Learning	
CIS 6300	Advanced Topics in Natural Language Processing	
CIS 6800	Advanced Topics in Machine Perception	

Human-Centered Computing:

CIS 5120	Introduction to Human Computer Interaction	
CIS 5230	Ethical Algorithm Design	
CIS 5640	Game Design and Development	
CIS 7980	Explaining Explanation	
CIS 5600	Interactive Computer Graphics	
CIS 5610	Advanced Computer Graphics	
CIS 5620	Computer Animation	
CIS 5630	Physically Based Animation	
CIS 5660	Procedural Computer Graphics	
CIS 6600	Advanced Topics in Computer Graphics and Animation	

Technical communication:

CIS 8100	Writing and Speaking with Style	
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Teaching Practicum

CIS 8950	Teaching Practicum	1
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Depth Requirement

Select four approved 5000-8000 level University courses	4
Independent Study	
CIS 8990 Doctoral Independent Study (Select 4 courses)	4
Research	
CIS 9990 Thesis/Dissertation Research (Select 2 required courses related to the Dissertation Research area plus 2 in an unrelated area)	2
Dissertation Status	
CIS 9950 Dissertation	0
Total Course Units	14

¹ Students are required to take and receive a grade of B or above in two courses spanning two of the five buckets.

² Two courses can be waived for students entering with a Master's degree. Advisor and Graduate Chair approval is required for non-CIS courses.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2024 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
