DREXEL UNIVERSITY
College of
Computing & Informatics

CATALOG
2024-2025

UNDERGRADUATE

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College of Computing & Informatics

At Drexel University's College of Computing & Informatics (CCI), you'll experience ingenuity at work – and a fierce intensity to invent the best future through technology.

From our position on the leading edge of information and technology, Drexel CCI instills the knowledge and skills necessary for our students to lead and innovate across industries in a rapidly evolving technological landscape.

Building on Drexel University's exceptional foundation of entrepreneurship and cooperative education, we provide unparalleled professional experiences and on-the-job training that is vital to preparing today's students for tomorrow's world. At CCI, our unique structure bringing computing and informatics together under one roof in a dynamic, collaborative college allows us to spot trends before they emerge, to solve problems before they occur, and to build a better tomorrow starting today.

The College contributes to theory and practice along dimensions that include technical, human, organizational, policy, and societal considerations. This broad perspective positions the College to address the complex, multi-disciplinary problems that are increasingly common as society becomes more dependent on information technology.

The College's academic programs provide broad and deep coverage of computing and informatics. For more information about the College, please visit the College's website (https://drexel.edu/cci/).

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About the College

The College of Computing & Informatics (https://drexel.edu/cci/) (CCI) offers a number of undergraduate degrees in computer science, computing and security technology, data science, information systems, and software engineering. The degree programs are open to freshmen and transfers from other departments at Drexel and other universities. Students have access to the computing facilities available to all Drexel students.

The College educates professionals through its interdisciplinary programs to meet a wide range of needs in the computing and informatics fields to benefit all sectors of society.

Transfer admission for traditional undergraduate programs occurs in the fall term only due to the sequence of required courses. Internal transfer students can be admitted at any term. Admission to the BS in Computing and Security Technology is offered on a rolling basis. Please contact an undergraduate advisor (https://drexel.edu/cci/current-students/undergraduate/advising/) for more information.

Cooperative Education

Cooperative education emphasizes career management through experiential learning as an integral part of the education process. The co-op is based on employment in practical, major-related positions consistent with the interests, abilities, and aptitudes of the students.

For more general information on Drexel University's co-op opportunities, visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/).

College of Computing & Informatics Faculty

Adelaida Alban Medlock, MS *(Drexel University) Associate Department Head for Undergraduate Affairs, Computer Science*. Teaching Professor. Introductory programming, computer science education

Yuan An, PhD *(University of Toronto, Canada) Director of International Programs*. Associate Professor. Conceptual modeling, schema and ontology mapping, information integration, knowledge representation, requirements engineering, healthcare information systems, semantic web.

Ram Arthanari, PhD *(Temple University)*. Assistant Teaching Professor. Knowledge Management, Digital Transformation, Project/Program/Portfolio Management, Risk Management, Cloud Computing, AI

Pragati Awasthi, MS *(Drexel University)*. Assistant Teaching Professor. Data Science, machine learning and applications.

Ellen Bass, PhD *(Georgia Institute of Technology) Interim Senior Associate Dean for Research*. Professor. Characterizing human judgement and decision making, modeling human judgement when supported by information automation, computational models of human-human and human-automation coordination, design and evaluation of interventions to improve human judgement and decision making.

Karthik Bhat Assistant Professor. Human-Centered Computing, Human-Centered AI, Care Work, ICTD

Mark Boady, PhD *(Drexel University)*. Associate Teaching Professor. Computer Algebra, complex symbolic calculations, automation of computation problems

David E. Breen, PhD *(Rensselaer Polytechnic Institute) Associate Department Head for Graduate Affairs, Computer Science*. Professor. Computer-aided design, biomedical image informatics, geometric modeling and self-organization algorithms.

Matthew Burlick, PhD *(Stevens Institute of Technology)*. Associate Teaching Professor. Image processing, machine learning, real-time video tracking, object detection and classification, statistics/probability, and acoustics

Yuanfang Cai, PhD *(University of Virginia)*. Professor. Formal software design modeling and analysis, software economics, software evolution and modularity.

Andrew Calhoun, MS *(American Military University)*. Assistant Teaching Professor. Social engineering, ethical hacking, information assurance, business continuity & disaster recovery planning, Computer forensics, and Computer security

Christopher Carroll, MS *(Drexel University) BSCST Program Director*. Teaching Professor. Information technology within healthcare companies, computer networking and design, IT infrastructure, server technology, information security, virtualization and cloud computing.

Preetha Chatterjee, PhD *(University of Delaware)*. Assistant Professor. Software engineering, data mining, natural language processing, and machine learning.

Chaomei Chen, PhD *(University of Liverpool)*. Professor. Information visualization, visual analytics, knowledge domain visualization, network analysis and modeling, scientific discovery, science mapping, scientometrics, citation analysis, human-computer interaction.

Trip Denton, PhD *(Drexel University)*. Assistant Teaching Professor. Computer Science

Tiffany Do Assistant Professor. Human-Centered AI, Virtual Avatars, Virtual Reality

Michael Ekstrand, PhD *(University of Minnesota)*. Assistant Professor. Recommender systems, information retrieval, algorithmic fairness, social impact of technology, AI ethics.

Joseph Gallego Assistant Teaching Professor. Computer vision, remote sensing, machine learning, quantum machine learning, natural language processing.

Vasilis Gkatzelis, PhD *(New York University)*. Associate Professor. Algorithmic mechanism design, multiagent resource allocation, approximation, algorithms.

Colin Gordon, PhD *(University of Washington)*. Associate Professor. Software reliability, program behavior, concurrent and systems-level code, formal assurance, programming models, distributed computing, and testing

Tim Gorichanaz, PhD *(Drexel University)*. Associate Teaching Professor. Human information behavior, human-centered computing, neo-documentation studies, and information ethics.

Jane Greenberg, PhD *(University of Pittsburgh) Alice B. Kroeger Professor and Director Metadata Research Center*. Metadata, ontological engineering, data science, knowledge organization, information retrieval

Sean Grimes, PhD *(Drexel University)*. Assistant Teaching Professor. Swarm intelligence, biologically inspired AI, multi-agent systems, software system design.

Scott Haag, PhD *(Drexel University)*. Assistant Research Professor. Remote sensing object classification, object segmentation, machine learning classifiers, algorithm design and complexity analysis, relational database development, statistical analysis, the design and deployment of Application Program Interfaces (API), and combinatoric geometric modelling.

Thomas Heverin, PhD *(Drexel University)*. Associate Teaching Professor. Computer security, ethical hacking, computer forensics, network forensics, cloud security and cybersecurity.

Gregory W. Hislop, PhD *(Drexel University)*. Professor. Information technology for teaching and learning, online education, structure and organization of the information disciplines, computing education research, software evaluation and characterization.

Xiaohua Tony Hu, PhD *(University of Regina, Canada)*. Professor. Data mining, text mining, Web searching and mining, information retrieval, bioinformatics, and healthcare informatics.

Shahin Jabbari, PhD *(University of Pennsylvania)*. Assistant Professor. Algorithmic fairness, game theory, and artificial intelligence for social good.

Jeremy R. Johnson, PhD *(Ohio State University) Department Head, Computer Science*. Professor. Computer algebra; parallel computations; algebraic algorithms; scientific computing.

Weimao Ke, PhD *(University of North Carolina at Chapel Hill) Associate Department Head for Graduate Affairs, Information Science*. Associate Professor. Information retrieval, distributed systems, intelligent filtering/ recommendation, information visualization, network science, complex systems, machine learning, text/data mining, multi-agent systems, the notion of information.

Mat Kelly, PhD *(Old Dominion University)*. Assistant Professor. Information retrieval, Web archives, metadata, digital humanities, archival privacy

Ehsan B. Khosroshahi, PhD *(Drexel University)*. Assistant Teaching Professor. Computational cognitive modeling, artificial intelligence, machine learning and data analysis.

Edward Kim, PhD *(Lehigh University)*. Associate Professor. Computer vision, Sparse coding, neuromorphic computing, medical image processing, computer graphics, artificial intelligence, game development

Feng Liu Assistant Professor. AI + X: Education; Healthcare. 3D Computer Vision: 3D object/scene understanding; 3D generation; VR/AR; 3D vision+language understanding. 3D Human Digitization: Modeling, reconstruction and rendering; Biomechanics. Generative AI: Explainability, generalization and controllability in generative models; DeepFake detection. Biometric Recognition: Face and gait recognition; Person re-identification

Galen Long, MS *(Drexel University)*. Assistant Teaching Professor. Computer Science.

Geoffrey Mainland, PhD *(Harvard University)*. Associate Professor. Programming systems and software engineering, high-level programming languages and runtime support for non-general purpose computation.

Spiros Mancoridis, PhD *(University of Toronto) The Auerbach Berger Chair in Cybersecurity Distinguished Professor of Computer Science*. Professor. Software engineering; software security; code analysis; evolutionary computation.

Helena Mentis, PhD *(Pennsylvania State University) Department Head, Information Science*. Professor. Human-computer interaction (HCI), computer supported cooperative work (CSCW), health informatics, AR/VR

Brian Mitchell, PhD *(Drexel University)*. Teaching Professor. Software engineering, software architecture, systems, cloud native computing.

Daniel Moix, MS *(Arkansas State University)*. Associate Teaching Professor. Computer science education.

Reza Moradinezhad, PhD *(Drexel University)*. Assistant Teaching Professor. Generative AI, human-AI trust, ethical AI.

Santiago Ontañón, PhD *(University of Barcelona)*. Associate Professor. Game AI, computer games, artificial intelligence, machine learning, case-based reasoning

Yusuf Osmanlioglu, PhD *(Drexel University)*. Assistant Teaching Professor. Graph theory and algorithms, brain network analysis, optimization, computer vision, natural language processing.

Jung-ran Park, PhD *(University of Hawaii at Manoa)*. Associate Professor. Knowledge organization and representation, metadata, computer-mediated communication, cross-cultural communication, multilingual information access, discourse and pragmatics.

Chad Peiper, PhD *(University of Ilinois)*. Associate Teaching Professor. Cloud computing, blockchain, self-sovereign identity, data privacy, decentralization.

Shruti Phadke Assistant Professor. Computational social science, social computing, natural language processing, human-computer interaction

Tammy Pirmann, Ed D *(Gwynedd Mercy University)*. Assistant Teaching Professor. Introductory programming, object-oriented programming, game design, mobile computing, computer science education, computer science educator pipeline

Alex Poole, PhD *(University of North Carolina)*. Associate Professor. Digital curation, archives and records management, digital humanities, and diversity, inclusivity, and equity.

Emmanouil Pountourakis, PhD *(Northwestern University)*. Assistant Professor. Algorithmic game theory, algorithmic mechanism design, algorithmic aspects of behavioral economics, game theory and learning, computational and game theoretic aspects of energy grids.

Afsaneh Razi, PhD *(University of Central Florida)*. Assistant Professor. Human-computer interaction, social computing, human-centered AI, privacy, ethics, online safety, language processing.

Shadi Rezapour, PhD *(University of Ilinois)*. Assistant Professor. Computational social science, natural language processing, network analysis, human-centered data science, computational linguistics.

Michelle L. Rogers, PhD *(University of Wisconsin-Madison) Directotr, Women in Tech Initiative*. Associate Professor. Human-computer interaction, healthcare informatics, human factors engineering, socio-technical systems, health services research, patient safety.

Jeffrey Salvage, MS *(Drexel University)*. Teaching Professor. Object-oriented programming, multi-agent systems, software engineering, database theory, introductory programming, data structures.

Dario Salvucci, PhD *(Carnegie Mellon University) Interim Associate Dean for Academic Operations*. Professor. Human computer interaction, cognitive science, machine learning, applications for driving.

Aleksandra Sarcevic, PhD *(Rutgers University)*. Professor. Computer-supported cooperative work, human-computer interaction, and healthcare informatics.

Kurt Schmidt, MS *(Drexel University)*. Associate Teaching Professor. Data structures, math foundations for computer science, programming tools, programming languages.

John Seberger, PhD *(University of California, Irvine)*. Assistant Professor. Human-computer interaction, human-centered computing, social informatics, privacy.

Bhupesh Shetty, PhD *(University of Iowa) Associate Department Head for Undergraduate Affairs, Information Science.*. Associate Teaching Professor. Process pattern mining, data mining, operations management, sports analytics, information systems, and machine learning applications.

Ali Shokoufandeh, PhD *(Rutgers University) Interim Dean*. Distinguished University Professor. Theory of algorithms, graph theory, combinational optimization, computer vision.

Il-Yeol Song, PhD *(Louisiana State University)*. Professor. Conceptual modeling, ontology and patterns, data warehouse and OLAP, object-oriented analysis and design with UML, medical and bioinformatics data modeling & integration.

Bo Song, PhD *(Drexel University)*. Assistant Teaching Professor. Data mining, bioinformatics, big data analytics and knowledge discovery.

Brian Stuart, PhD *(Purdue University)*. Associate Teaching Professor. Machine learning, networking, robotics, image processing, simulation, interpreters, data storage, operating systems, computer science, data communications, distributed/operating systems, accelerated computer programming, computer graphics.

Nadia Sultanik, MS *(Drexel University)*. Assistant Teaching Professor. Computer Science

Eric Sun, PhD *(Arizona State University)*. Assistant Professor. Computer security and privacy.

Hegler Tissot, PhD *(Universidade Federal do Parana)*. Assistant Teaching Professor. Knowledge representation and reasoning, machine learning, natural language processing, ontologies, pattern recognition, statistical analysis, and information extraction, health informatics.

Milad Toutounchian, PhD *(Simon Fraser University)*. Assistant Teaching Professor. Data science, applied machine learning and deep learning.

Boris Valerstein, MS *(Pennsylvania State University)*. Assistant Teaching Professor. Computer science.

Filippos Vokolos, PhD *(Polytechnic University)*. Associate Teaching Professor. System architecture, principles of software design and construction, foundations of software engineering, software verification

& validation, software design, programming languages, dependable software systems.

Lei Wang, PhD *(Drexel University)*. Assistant Teaching Professor. Biomedical data science, machine learning, deep learning, neuroimaging processing & analytics, natural language processing, simulation modeling.

Rosina Weber, PhD *(Federal University of Santa Catarina in a "sandwich" program with University of South Florida)*. Professor. Case-based reasoning, explainable artificial intelligence, machine learning, textual analytics, natural language understanding, language models, recommender systems, technological aspects of knowledge management, project management, and requirements engineering.

Heather Willever-Farr Assistant Teaching Professor. Library science pedagogy, digital archives, user experience and information systems, online information-seeking behaviors, data curation

Jake Williams, PhD *(University of Vermont)*. Associate Professor. Data science, scientific programming, computational social science, computational linguistics and natural language processing, mathematics, machine learning, algorithms, and scalability.

Kaidi Xu, PhD *(Northeastern University)*. Assistant Professor. AI security, explainable artificial intelligence, optimization.

Erija Yan, PhD *(Indiana University Bloomington)*. Associate Professor. Network Science, information analysis and retrieval, scholarly communication methods and applications.

Christopher C. Yang, PhD *(University of Arizona)*. Professor. Web search and mining, security informatics, knowledge management, social media analytics, cross-lingual information retrieval, text summarization, multimedia retrieval, information visualization, information sharing and privacy, artificial intelligence, digital library, and electronic commerce.

Yue Zhang, PhD *(Jinan University)*. Assistant Professor. IoT Security, Mobile Security, Program Analysis

Li "Harry" Zhang Assistant Professor. Natural Language Processing, Large Language Models, Artificial Intelligence, AI and Games, AI and Creativity

Emeritus Faculty

Michael E. Atwood, PhD *(University of Colorado)*. Professor Emeritus. Human-computer interaction, computer-supported cooperative work, organizational memory.

Bruce W. Char, PhD *(University of California-Berkeley)*. Professor Emeritus. Symbolic mathematical computation, algorithms and systems for computer algebra, problem-solving environments parallel and distributed computation.

Thomas A. Childers, PhD *(Rutgers University)*. Professor Emeritus. Measurement, evaluation, and planning of information and library services, the effectiveness of information organizations.

Yi Deng, PhD *(University of Pittsburgh) Dean Emeritus*. Distinguished University Professor. Computing and informatics

David E. Fenske, PhD *(University of Wisconsin-Madison)*. Dean Emeritus and Professor. Digital libraries, informatics, knowledge management and information technologies.

Susan Gasson, PhD *(University of Warwick)*. Associate Professor. The co-design of business and IT-systems, distributed cognition & knowledge management in boundary-spanning groups, human-centered design, social informatics, online learning communities, grounded theory.

Peter Grillo, PhD *(Temple University)*. Teaching Professor. Software economics, Project management, strategic applications of technology within organizations.

John B. Hall, PhD *(Florida State University)*. Professor Emeritus. Academic library service, library administration, organization of materials.

Xia Lin, PhD *(University of Maryland at College Park)*. Professor. Digital libraries, information visualization, visual interface design, knowledge mapping, human-computer interaction, information retrieval, information architecture, informetrics, information-seeking behaviors in digital environments.

Katherine W. McCain, PhD *(Drexel University)*. Professor Emeritus. Scholarly communication, information production and use in the research process, development and structure of scientific specialties, diffusion of innovation, bibliometrics, evaluation of information retrieval systems.

Carol Hansen Montgomery, PhD *(Drexel University) Dean of Libraries Emeritus*. Research Professor. Selection and use of electronic collections, evaluation of library and information systems, digital libraries, economics of libraries and digital collections.

Delia Neuman, PhD *(The Ohio State University)*. Professor Emerita. Learning in information-rich environments, instructional systems design, the use of media for learning, and school library media.

Danuta A. Nitecki, PhD *(University of Maryland at College Park)*. Professor. Library metrics and use in management, library as place, and academic library service models.

Jeffrey L. Popyack, PhD *(University of Virginia)*. Professor. Operations research, stochastic optimization, computational methods of Markov decision processes; artificial intelligence, computer science education.

Gerry Stahl, PhD *(University of Colorado)*. Professor Emeritus. Human-computer interaction, computer-supported cooperative work, computer-supported collaborative learning, theory of collaboration.

Howard D. White, PhD *(University of California at Berkeley)*. Professor Emeritus. Literature information systems, bibliometrics, research methods, collection development, online searching.

Computer Science BA

Major: Computer Science
Degree Awarded: Bachelor of Arts in Computer Science (BACS)
Calendar Type: Quarter
Minimum Required Credits: 187.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Programs (CIP) code: 11.0701
Standard Occupational Classification (SOC) code: 11-3021; 15-1111; 15-1131; 15-1132; 11-1199

About the Program

The College of Computing & Informatics' Bachelor of Science/Arts in Computer Science offers extensive exposure and hands-on practice in the core areas of the field, including programming paradigms and languages, algorithms, systems, networking, and software engineering. Students also focus their upper level studies with specializations in areas such as artificial intelligence and machine learning, security, graphics and vision, and game programming/development. The program's flexibility allows students to easily sample from areas in which they would like to apply their computing knowledge. This hands-on curriculum combined with co-op provides real-world experience that culminates in a full-year team capstone project (https://drexel.edu/cci/student-experience/senior-project/) involving in-depth study and application of computing and informatics.

The programs of study in computer science are designed with the versatility to prepare students for careers in a rapidly changing profession and to allow strong preparation for graduate education in the field. In addition to the courses in the major, the programs emphasize foundation courses in the sciences and in applied mathematics. The programs also provide sufficient flexibility with electives to permit a student to pursue a minor in a technical or non-technical field. Computer Science graduates are in demand in any discipline where computing expertise is needed, from the computing industry to science and technical applications to the arts.

Students should contact their advisor (https://drexel.edu/cci/current-students/undergraduate/advising/) at the College of Computing & Informatics for a current list of computer science concentration and elective courses.

Concentrations

- Algorithms and Theory
- Artificial Intelligence and Machine Learning
- Computer Graphics, Vision, and Interaction
- Computer Security and Privacy
- Computer Systems & Architecture
- Game Programming and Development
- Programming Languages and Systems
- Software Engineering

Additional Information

For more information about this program, please visit the BS/BA in Computer Science webpage (https://drexel.edu/cci/academics/undergraduate-programs/bsba-computer-science/) on the College of Computing & Informatics website.

Degree Requirements

The Bachelor of Arts (BA) in Computer Science program emphasizes foundation courses in the humanities and the social sciences, leading to careers involving applications in those areas.

Computer Science Requirements		
CS 164	Introduction to Computer Science	3.0
CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
CS 172	Computer Programming II	3.0
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
CS 277	Algorithms and Analysis	3.0
CS 281	Systems Architecture	4.0
CS 283	Systems Programming	3.0
CS 360	Programming Language Concepts	3.0
SE 181	Introduction to Software Engineering and Development	3.0
or SE 201	Introduction to Software Engineering and Development	

SE 310	Software Architecture I	3.0
Computer Science concentration courses (see below)		18.0
Computer Science electives (see below)		6.0
Computing & Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Mathematics Requirements		
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 123	Calculus III	4.0
MATH 200	Multivariate Calculus	4.0
MATH 201	Linear Algebra	4.0
MATH 221	Discrete Mathematics	3.0
MATH 311	Probability and Statistics I	4.0
Science Requirements		**18.0**
Select one of the following lab science sequences plus science electives from below:		
BIO 131	Cells and Biomolecules	
& BIO 134	and Cells and Biomolecules Lab	
& BIO 132	and Genetics and Evolution	
& BIO 135	and Genetics and Evolution Lab	
& BIO 133	and Physiology and Ecology	
& BIO 136	and Anatomy and Ecology Lab	
CHEM 101	General Chemistry I	
& CHEM 102	and General Chemistry II	
& CHEM 103	and General Chemistry III	
PHYS 101	Fundamentals of Physics I	
& PHYS 102	and Fundamentals of Physics II	
& PHYS 201	and Fundamentals of Physics III	
Arts & Humanities Requirements		
COM 230	Techniques of Speaking	3.0
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
PHIL 311	Ethics and Information Technology	3.0
Arts Humanities, Business, or Social Studies electives (see below)		6.0
Disciplinary Minor		**24.0**
University Requirements		
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development *	1.0
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
Free electives		**16.0**
Total Credits		**187.0**

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Program Electives

Independent study courses and special topics courses must be approved by the department prior to enrollment to satisfy a program elective requirement.

- **Computer Science electives**: any CS or SE course (300-499) or any of the following courses: DSCI 351, DSCI 471, INFO 310, INFO 323, ECE 302, ECEC 412, ECEC 413, GMAP 377, GMAP 378, MATH 300, MATH 301, MATH 305, MATH 475.

- **Science electives**: any CHEM (100-499 [except CHEM 111, CHEM 112, CHEM 113, CHEM 114, CHEM 151]), BIO (100-499 [except BIO 161, BIO 162, BIO 163; can take only one of BIO 100, BIO 107; can take only one of BIO 101, BIO 109]), PHYS (100-499 [except PHYS 050, PHYS 100, PHYS 105,PHYS 151, PHYS 160, PHYS 305, PHYS 324, PHYS 405; cannot take both PHYS 131 & PHYS 181]); ENVS (100-499), ENSS (100-499), PHEV (100-499)
- **Social Studies electives**: any AFAS (100-499), ANTH (100-499), GST (100-499), HIST (100-499), JWST (100-499), PSCI (100-499), PSY (100-499), SOC (100-499), WGST (100-499)
- **Arts & Humanities electives**: any ARCH (100-499), ARTH (100-499), CMGT (100-499), CJS (100-499), COM (100-499), CULA (100-499), DANC (100-499), EDEX (100-499), EDUC (100-499), ENGL (100-499) [except ENGL 101, ENGL 102, ENGL 103, ENGL 111,ENGL 112,ENGL 113]), ESTM (100-499), FASH (100-499), FMST (100-499), FMTV (100-499), GST (100-499), INTR (100-499), LING (100-499), MUSC (100-499), PHIL (100-499), PHTO (100-499), THTR (100-499), VSCM (100-499), VSST (100-499), WRIT (100-499), Foreign Language (any undergraduate course 101-499 in ARBC, CHIN, FREN, GER, HBRW, ITAL, JAPN, KOR, SPAN, including independent studies and special topics) and GMAP 260, ANIM 140, ANIM 141, ANIM 211, ANIM 212
- **Business electives:** any ACCT (100-499), BLAW (100-499), BUSN (100-499), ECON (100-499), ENTP (100-499), FIN (100-499), HRMT (100-499), INTB (100-499), MGMT (100-499), MIS (100-499), MKTG (100-499), OPM (100-499), OPR (100-499), ORGB (100-499), STAT (100-499), TAX (100-499)

Computer Science Concentrations

Students must complete two of the following Computer Science concentrations for a total of 18.0 credits. The concentrations may overlap by one course. Students should check with the College for any additional Special Topics courses being offered that may be appropriate for one of the concentrations. The student may propose a custom-designed concentration with departmental approval; courses proposed must be of level 300 and above.

The selected concentrations require 3 courses with a minumum of 9 credits and at least one Core Course (*).

Algorithms and Theory	
CS 300	Applied Symbolic Computation
CS 303	Algorithmic Number Theory and Cryptography
CS 440	Theory of Computation *
CS 441	Compiler Implementation
CS 457	Data Structures and Algorithms I *
CS 458	Data Structures and Algorithms II
MATH 300	Numerical Analysis I
MATH 301	Numerical Analysis II
MATH 305	Introduction to Optimization Theory
MATH 475	Cryptography
Computer Systems & Architecure	
CS 314	Computing in the Small
CS 352	Processor Architecture & Analysis
CS 361	Concurrent Programming
CS 370	Operating Systems *
CS 429	Software Defined Radio Laboratory
CS 441	Compiler Implementation
CS 461	Database Systems *
CS 472	Computer Networks: Theory, Applications and Programming *
CS 475	Network Security
CS 476	High Performance Computing
CS 479	Advanced Network Security
ECE 302	Design with Embedded Processors
ECEC 412	Modern Processor Design
ECEC 413	Introduction to Parallel Computer Architecture
ECEC 414	High Performance Computing
INFO 323	Cloud Computing and Big Data
Programming Languages and Systems	
CS 361	Concurrent Programming *
CS 370	Operating Systems
CS 377	Software Security
CS 429	Software Defined Radio Laboratory
CS 440	Theory of Computation *
CS 441	Compiler Implementation
CS 461	Database Systems
ECEC 413	Introduction to Parallel Computer Architecture
Computer Graphics, Vision, and Interaction	
CS 314	Computing in the Small

CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development
CS 375	Web Development *
CS 387	Game AI Development
CS 430	Computer Graphics
CS 431	Advanced Rendering Techniques
CS 432	Interactive Computer Graphics *
CS 435	Computational Photography
CS 438	Game Engine Programming
CS 478	Advanced Web Development
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II
INFO 310	Human-Centered Design Process & Methods
Artificial Intelligence and Machine Learning	
CS 380	Artificial Intelligence *
CS 383	Machine Learning
CS 385	Evolutionary Computing
CS 387	Game AI Development
CS 455	Computational Network Neuroscience
CS 481	Advanced Artificial Intelligence
CS 482	Robust Machine Learning
CS 486	Topics in Artificial Intelligence
DSCI 351	Recommender Systems
DSCI 471	Applied Deep Learning
Computer Security and Privacy	
CS 300	Applied Symbolic Computation
CS 303	Algorithmic Number Theory and Cryptography
CS 377	Software Security *
CS 465	Privacy and Trust
CS 475	Network Security *
CS 479	Advanced Network Security
MATH 475	Cryptography
Software Engineering	
CS 375	Web Development
CS 478	Advanced Web Development
INFO 420	Software Project Management
SE 311	Software Architecture II *
SE 320	Software Verification and Validation *
SE 410	Software Evolution
SE 420	Open Source Software Engineering
Game Programming and Development	
CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development *
CS 387	Game AI Development
CS 438	Game Engine Programming
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II

* CORE COURSE

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-

philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

4 year, one co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101 or 111	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171 or 175	3.0	MATH 123	4.0		
UNIV C101	1.0	ENGL 102 or 112	3.0	UNIV C101	1.0		
Arts/Humanities elective	3.0	MATH 122	4.0	Science Lab	4.5		
		Science lab	4.5				
	16		**18.5**		**17.5**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	CS 260	4.0	COM 230	3.0	CS 283	3.0
CS 270	3.0	MATH 221	3.0	CS 277	3.0	CS 360	3.0
MATH 201	4.0	Disciplinary Minor elective	3.0	CS 281	4.0	MATH 200	4.0
SE 181 or 201	3.0	Free elective	2.0	SE 310	3.0	Disciplinary Minor elective	3.0
Disciplinary Minor elective	3.0	Science elective	4.5	Disciplinary Minor elective	3.0	Science lab	4.5
	16		**16.5**		**16**		**17.5**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
MATH 311	4.0	Arts & Humanities, Business, and Social Studies elective	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 311	3.0	Computer Science elective	3.0				
Computer Science electives	6.0	Disciplinary Minor electives	6.0				
Disciplinary Minor elective	3.0	Free elective	3.0				
	16		**15**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
Computer Science electives	6.0	Computer Science electives	6.0	Computer Science elective	3.0
Disciplinary Minor elective	3.0	Free elective	3.0	Free electives	6.0
Free elective	2.0				
	14		**12**		**12**

Total Credits 187

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

5 year, 3 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171 or 175	3.0	MATH 123	4.0		

UNIV C101	1.0	ENGL 102 or 112	3.0	UNIV C101	1.0		
Arts/Humanities elective	3.0	MATH 122	4.0	Science lab	4.5		
		Science lab	4.5				
	16		**18.5**		**17.5**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	CS 260	4.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 270	3.0	MATH 221	3.0				
MATH 201	4.0	Disciplinary Minor elective	3.0				
SE 181 or 201	3.0	Free elective	2.0				
Disciplinary Minor elective	3.0	Science elective	4.5				
	16		**16.5**		**0**		**0**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 230	3.0	CS 283	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 277	3.0	CS 360	3.0				
CS 281	4.0	MATH 200	4.0				
SE 310	3.0	Disciplinary Minor elective	3.0				
Disciplinary Minor elective	3.0	Science Lab	4.5				
	16		**17.5**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
MATH 311	4.0	Arts & Humanities, Business, and Social Studies elective	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 311	3.0	Computer Science elective	3.0				
Computer Science electives	6.0	Disciplinary Minor electives	6.0				
Disciplinary Minor elective	3.0	Free elective	3.0				
	16		**15**		**0**		**0**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
Computer Science electives	6.0	Computer Science electives	6.0	Computer Science elective	3.0
Disciplinary Minor elective	3.0	Free elective	3.0	Free electives	6.0
Free elective	2.0				
	14		**12**		**12**

Total Credits 187

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.

COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

Career Opportunities

The demand for computing skills is tremendous and growing with highly paid jobs. Most professionals in the field focus on the design and development of software and software-based applications. Typical jobs include software engineer, programmer, web designer, multimedia or software developer, systems analyst or consultant, manager of technical staff, client-server architect, network designer, and database specialist. Most positions require at least a bachelor's degree. Relevant work experience, such as that provided by co-operative education, is also very important, as cited by the Occupational Outlook Handbook (http://www.bls.gov/ooh/) published by the US Bureau of Labor Statistics.

Job titles of recent computer science graduates include:

- Web Developer
- Software Systems Engineer
- Software Developer
- Network Engineer
- Application Analyst

Additional Information

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more detailed information on co-op and post-graduate opportunities.

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)
- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center
- Adjacent to future public square
- Access to Science Center's nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries' various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons' Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's fully equipped conference room with 42" displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI

Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching" platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University's network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory
- Over 556 TB of HDD-backed storage
- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College's research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the Computer Science degree is evaluated relative to the following Objectives and Outcomes.

Computer Science Program Educational Objectives

Drexel Computer Science alumni will:

- Be valued employees in a wide variety of occupations in industry, government and academia, in particular as computer scientists and software engineers
- Succeed in graduate and professional studies, such as engineering, science, law, medicine, and business
- Pursue life-long learning and professional development to remain current in an ever-changing technological world
- Provide leadership in their profession, in their communities, and society
- Function as responsible members of society with an awareness of the social and ethical ramifications of their work

Computer Science Student Outcomes (for Bachelor of Science and Bachelor of Arts)

The Drexel Computer Science program enables students to attain by the time of graduation:

- An ability to apply knowledge of computing and mathematics appropriate to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security, and social issues and responsibilities
- An ability to communicate effectively with a range of audiences
- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice
- An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
- An ability to apply design and development principles in the construction of software systems of varying complexity

Computer Science BSCS

Major: Computer Science
Degree Awarded: Bachelor of Science in Computer Science (BSCS)
Calendar Type: Quarter
Minimum Required Credits: 187.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Programs (CIP) code: 11.0701
Standard Occupational Classification (SOC) code: 11-3021; 15-1111; 15-1131; 15-1132; 11-1199

About the Program

The College of Computing & Informatics' Bachelor of Science/Arts in Computer Science offers extensive exposure and hands-on practice in the core areas of the field, including programming paradigms and languages, algorithms, systems, networking, and software engineering. Students also focus their upper-level studies with specializations in areas such as artificial intelligence and machine learning, security, graphics and vision, and game programming/development. The program's flexibility allows students to easily sample from areas in which they would like to apply their computing knowledge. This hands-on curriculum combined with co-op provides real-world experience that culminates in a full-year team capstone project (https://drexel.edu/cci/student-experience/senior-project/) involving in-depth study and application of computing and informatics.

The programs of study in computer science are designed with the versatility to prepare students for careers in a rapidly changing profession and to allow strong preparation for graduate education in the field. In addition to the courses in the major, the programs emphasize foundation courses in the sciences and in applied mathematics. The programs also provide sufficient flexibility with electives to permit a student to pursue a minor in a technical or non-technical field. Computer Science graduates are in demand in any discipline where computing expertise is needed, from the computing industry to science and technical applications to the arts.

Students should contact their advisor (https://drexel.edu/cci/current-students/undergraduate/advising/) at the College of Computing & Informatics for a current list of computer science concentration and elective courses.

Concentrations

- Algorithms and Theory
- Artificial Intelligence and Machine Learning
- Computer Graphics, Vision, and Interaction
- Computer Security and Privacy
- Computer Systems & Architecture
- Game Programming and Development

- Programming Languages and Systems
- Software Engineering

Additional Information

For more information about this program, please visit the BS/BA in Computer Science webpage (https://drexel.edu/cci/academics/undergraduate-programs/bsba-computer-science/) on the College of Computing & Informatics website.

Degree Requirements

The Bachelor of Science (BS) in Computer Science program emphasizes foundation courses in the sciences and in applied mathematics, leading to careers involving applications in science and engineering.

Computer Science Requirements		
CS 164	Introduction to Computer Science	3.0
CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
CS 172	Computer Programming II	3.0
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
CS 277	Algorithms and Analysis	3.0
CS 281	Systems Architecture	4.0
CS 283	Systems Programming	3.0
CS 360	Programming Language Concepts	3.0
SE 181	Introduction to Software Engineering and Development	3.0
or SE 201	Introduction to Software Engineering and Development	
SE 310	Software Architecture I	3.0
Computer Science concentration courses (see below)		18.0
Computer Science electives (see below)		6.0
Computing & Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Mathematics Requirements		
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 123	Calculus III	4.0
MATH 200	Multivariate Calculus	4.0
MATH 201	Linear Algebra	4.0
MATH 221	Discrete Mathematics	3.0
MATH 311	Probability and Statistics I	4.0
Science Requirements		**19.0**
Select one of the following lab science sequences:		
BIO 131	Cells and Biomolecules	
& BIO 134	and Cells and Biomolecules Lab	
& BIO 132	and Genetics and Evolution	
& BIO 135	and Genetics and Evolution Lab	
& BIO 133	and Physiology and Ecology	
& BIO 136	and Anatomy and Ecology Lab	
Or		
CHEM 101	General Chemistry I	
& CHEM 102	and General Chemistry II	
& CHEM 103	and General Chemistry III	
Or		
PHYS 101	Fundamentals of Physics I	
& PHYS 102	and Fundamentals of Physics II	
& PHYS 201	and Fundamentals of Physics III	
Additional science electives to have total 19 credits (see below)		
Arts & Humanities Requirements		
COM 230	Techniques of Speaking	3.0

ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
PHIL 311	Ethics and Information Technology	3.0
Writing & Communication electives (see below)		6.0
Arts & Humanities, Business, or Social Studies electives (see below) *		18.0
University Requirements		
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development **	1.0
Free electives		**21.0**
Total Credits		**187.0**

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At least 3.0 credit must be taken from a Business category course (see below) and at least 3.0 credits must be from a Social Studies category course (see below)

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Program Electives

Independent study courses and special topics courses must be approved by the department prior to enrollment to satisfy a program elective requirement.

- **Computer Science electives**: any undergraduate CS or SE course (300-499) or any of the following courses: DSCI 351, DSCI 471, INFO 310, INFO 323, ECE 302, ECEC 412, ECEC 413, GMAP 377, GMAP 378, MATH 300, MATH 301, MATH 305, MATH 475.
- **Science electives**: any CHEM (100-499 [except CHEM 111, CHEM 112, CHEM 113, CHEM 114, CHEM 151]), BIO (100-499 [except BIO 161, BIO 162, BIO 163; can take only one of BIO 100, BIO 107; can take only one of BIO 101, BIO 109]), PHYS (100-499 [except PHYS 050, PHYS 100, PHYS 105, PHYS 151, PHYS 160, PHYS 305, PHYS 324,PHYS 405; cannot take both PHYS 131 & PHYS 181]), ENVS (100-499), ENSS (100-499), PHEV (100-499)
- **Writing & Communications electives**: any undergraduate WRIT (100-499), COM (100-499), ENGL (100-499) courses officially certified as Writing Intensive (http://drexel.edu/engphil/about/DrexelWritingCenter/wiCourses/course_list/) (WI), SCRP 270 [WI] and SCRP 275 [WI]
- **Business electives**: any undergraduate ACCT (100-499), BLAW (100-499), BUSN (100-499), ECON (100-499), ENTP (100-499), FIN (100-499), HRMT (100-499), INTB (100-499), MGMT (100-499), MIS (100-499), MKTG (100-499), OPM (100-499), OPR (100-499), ORGB (100-499), STAT (100-499), TAX (100-499)
- **Social Studies electives**: any undergraduate AFAS (100-499), ANTH (100-499), GST (100-499), HIST (100-499), JWST (100-499), PSCI (100-499), PSY (100-499), SOC (100-499), WGST (100-499)
- **Arts & Humanities electives**: any undergraduate ARCH (100-499), ARTH (100-499), CMGT (100-499), CJS (100-499), COM (100-499), CULA (100-499), DANC (100-499), EDEX (100-499), EDUC (100-499), ENGL (100-499 [except ENGL 101, ENGL 102, ENGL 103, ENGL 105, ENGL 111, ENGL 112, ENGL 113]), ESTM (100-499), FASH (100-499), FMST (100-499), FMTV (100-499), GST (100-499), INTR (100-499), LING (100-499), MUSC (100-499), PHIL (100-499), PHTO (100-499), THTR (100-499), VSCM (100-499), VSST (100-499), WRIT (100-499), Foreign Language (any undergraduate courrse 101-499 in ARBC, CHIN, FREN, GER, HBRW, ITAL, JAPN, KOR, SPAN, including independent studies and special topics), and GMAP 260, ANIM 140, ANIM 141, ANIM 211, ANIM 212

Computer Science Concentrations

Students must complete two of the following Computer Science concentrations for a total of 18.0 credits. The concentrations may overlap by one course. Students should check with the College for any additional Special Topics courses being offered that may be appropriate for one of the concentrations. The student may propose a custom-designed concentration with departmental approval; courses proposed must be of level 300 and above.

The selected concentrations require 3 courses with a minumum of 9 credits and at least one Core Course (*).

Algorithms and Theory	
CS 300	Applied Symbolic Computation
CS 303	Algorithmic Number Theory and Cryptography
CS 440	Theory of Computation *

CS 441	Compiler Implementation
CS 457	Data Structures and Algorithms I *
CS 458	Data Structures and Algorithms II
MATH 300	Numerical Analysis I
MATH 301	Numerical Analysis II
MATH 305	Introduction to Optimization Theory
MATH 475	Cryptography
Computer Systems & Architecture	
CS 314	Computing in the Small
CS 352	Processor Architecture & Analysis
CS 361	Concurrent Programming
CS 370	Operating Systems *
CS 429	Software Defined Radio Laboratory
CS 441	Compiler Implementation
CS 461	Database Systems *
CS 472	Computer Networks: Theory, Applications and Programming *
CS 475	Network Security
CS 476	High Performance Computing
CS 479	Advanced Network Security
ECE 302	Design with Embedded Processors
ECEC 412	Modern Processor Design
ECEC 413	Introduction to Parallel Computer Architecture
ECEC 414	High Performance Computing
INFO 323	Cloud Computing and Big Data
Programming Languages and Systems	
CS 361	Concurrent Programming *
CS 370	Operating Systems
CS 377	Software Security
CS 429	Software Defined Radio Laboratory
CS 440	Theory of Computation *
CS 441	Compiler Implementation
CS 461	Database Systems
ECEC 413	Introduction to Parallel Computer Architecture
Computer Graphics, Vision, and Interaction	
CS 314	Computing in the Small
CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development
CS 375	Web Development *
CS 387	Game AI Development
CS 430	Computer Graphics
CS 431	Advanced Rendering Techniques
CS 432	Interactive Computer Graphics *
CS 435	Computational Photography
CS 438	Game Engine Programming
CS 478	Advanced Web Development
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II
INFO 310	Human-Centered Design Process & Methods
Artificial Intelligence and Machine Learning	
CS 380	Artificial Intelligence *
CS 383	Machine Learning
CS 385	Evolutionary Computing
CS 387	Game AI Development
CS 455	Computational Network Neuroscience
CS 481	Advanced Artificial Intelligence
CS 482	Robust Machine Learning
CS 486	Topics in Artificial Intelligence
DSCI 351	Recommender Systems
DSCI 471	Applied Deep Learning
Computer Security and Privacy	
CS 300	Applied Symbolic Computation

CS 303	Algorithmic Number Theory and Cryptography
CS 377	Software Security *
CS 465	Privacy and Trust
CS 475	Network Security *
CS 479	Advanced Network Security
MATH 475	Cryptography
Software Engineering	
CS 375	Web Development
CS 478	Advanced Web Development
INFO 420	Software Project Management
SE 311	Software Architecture II *
SE 320	Software Verification and Validation *
SE 410	Software Evolution
SE 420	Open Source Software Engineering
Game Programming and Development	
CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development *
CS 387	Game AI Development
CS 438	Game Engine Programming
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II

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Core Course

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

5-Year, 3 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101 or 111	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171 or 175	3.0	MATH 123	4.0		
UNIV CI101	1.0	ENGL 102 or 112	3.0	UNIV CI101	1.0		
Arts/Humanities	3.0	MATH 122	4.0	Science Lab	4.5		
		Science Lab	4.5				
	16		**18.5**		**17.5**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	CS 260	4.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 270	3.0	MATH 200	4.0				
MATH 201	4.0	MATH 221	3.0				
SE 181 or 201	3.0	Free Elective	2.0				
Science Lab	4.0	Science Elective	3.0				
	17		**16**		**0**		**0**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 230	3.0	CS 283	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 277	3.0	CS 360	3.0				
CS 281	4.0	Free Elective	3.0				
SE 310	3.0	Science Elective	3.0				
Free Elective	3.0	Writing & Communication Elective	3.0				
	16		**15**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
MATH 311	4.0	Social Studies elective	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 311	3.0	Arts/Humanities	3.0				
Arts & Humanities Elective	3.0	Computer Science Elective	3.0				
Computer Science Electives	6.0	Free Elective	3.0				
		Free Elective	3.0				
	16		**15**		**0**		**0**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
Arts & Humanities Elective	3.0	Arts & Humanities Elective	3.0	Computer Science Elective	3.0
Computer Science Electives	6.0	Computer Science Electives	6.0	Free Elective	3.0
Free Elective	4.0			Writing & Communication Elective	3.0
	16		**12**		**12**

Total Credits 187

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4 year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

4-Year, 1 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0
CS 164	3.0	CIVC 101	1.0	CS 172	3.0
MATH 121	4.0	CS 171 or 175	3.0	ENGL 103 or 113	3.0
ENGL 101 or 111	3.0	ENGL 102 or 112	3.0	MATH 123	4.0
UNIV CI101	1.0	MATH 122	4.0	UNIV CI101	1.0
Arts/Humanities	3.0	Science Lab	4.5	Science Lab	4.5
	16		**17.5**		**17.5**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	CS 260	4.0	COM 230	3.0	CS 283	3.0
CS 270	3.0	COOP 101*	1.0	CS 277	3.0	CS 360	3.0
MATH 201	4.0	MATH 200	4.0	CS 281	4.0	Science Elective	3.0
SE 181 or 201	3.0	MATH 221	3.0	SE 310	3.0	Writing & Communication Elective	3.0
Science Lab	4.0	Science Elective	3.0	Free Elective	3.0	Free Elective	4.0
	17		**15**		**16**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
MATH 311	4.0	Business Elective	4.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 311	3.0	Computer Science Elective	6.0				
Computer Science Electives	3.0	Free Elective	3.0				

Arts & Humanities Elective	4.0						
Free Elective	3.0						
	17		**13**		**0**		**0**

Fourth Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**
CI 491	3.0	CI 492	3.0	CI 493	3.0
Arts & Humanities Elective	3.0	Arts & Humanities Elective	4.0	Computer Science Elective	3.0
Computer Science Electives	6.0	Computer Science Electives	6.0	Writing & Communications Elective	3.0
Free Elective	4.0			Free Elective	4.0
	16		**13**		**13**

Total Credits 187

*****

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer only) based on their co-op program (5-year or 4-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

Career Opportunities

The demand for computing skills is tremendous and growing with highly paid jobs. Most professionals in the field focus on the design and development of software and software-based applications. Typical jobs include software engineer, programmer, web designer, multimedia or software developer, systems analyst or consultant, manager of technical staff, client-server architect, network designer, and database specialist. Most positions require at least a bachelor's degree. Relevant work experience, such as that provided by co-operative education, is also very important, as cited by the Occupational Outlook Handbook (http://www.bls.gov/ooh/) published by the US Bureau of Labor Statistics.

Job titles of recent computer science graduates include:

- Web Developer
- Software Systems Engineer
- Software Developer
- Network Engineer
- Application Analyst

Additional Information

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more detailed information on co-op and post-graduate opportunities.

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)

- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center
- Adjacent to future public square
- Access to Science Center’s nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries’ various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons’ Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's fully equipped conference room with 42” displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching” platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University’s network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory
- Over 556 TB of HDD-backed storage
- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College's research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the Computer Science degree is evaluated relative to the following Objectives and Outcomes.

Computer Science Program Educational Objectives

Drexel Computer Science alumni will:

- Be valued employees in a wide variety of occupations in industry, government and academia, in particular as computer scientists and software engineers
- Succeed in graduate and professional studies, such as engineering, science, law, medicine, and business
- Pursue life-long learning and professional development to remain current in an ever-changing technological world
- Provide leadership in their profession, in their communities, and society
- Function as responsible members of society with an awareness of the social and ethical ramifications of their work

Computer Science Student Outcomes (for Bachelor of Science and Bachelor of Arts)

The Drexel Computer Science program enables students to attain by the time of graduation:

- An ability to apply knowledge of computing and mathematics appropriate to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security, and social issues and responsibilities
- An ability to communicate effectively with a range of audiences
- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice
- An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices
- An ability to apply design and development principles in the construction of software systems of varying complexity

Computing and Security Technology BSCST

Major: Computing and Security Technology
Degree Awarded: Bachelor of Science in Computing and Security Technology (BSCST)
Calendar Type: Quarter
Minimum Required Credits: 185.0

Co-op Options: Three Co-op (Five years); One Co-op (Four years); No Co-op (Four years)
Classification of Instructional Programs (CIP) Code: 11.1003
Standard Occupational Classification (SOC) Code: 15-1122

Note: **The on-campus CST major (full-time only) admits new and transfer students in Fall Quarter. The online CST major (part-time only) admits transfer students in Fall and Spring Quarters.**

About the Program

The College of Computing & Informatics' Bachelor of Science in Computing and Security Technology (BSCST) prepares students for work related to securing and managing large-scale computing infrastructure. Students gain experience with core information technology (IT) areas including servers, databases, networks, the Web, virtualization, cloud computing, information security, and cybersecurity technologies. The program emphasizes practical education and fundamental concepts that are supplemented by laboratory experience.

Core courses provide students with practical knowledge and skills related to managing servers, network administration, database administration, cloud computing and cybersecurity fundamentals. Students take advanced electives and a concentration in either Computing Technology or Computing Security. The advanced courses include topics such as mobile applications, wireless networks, risk assessment, intrusion detection, security audits, computer forensics, ethical hacking, cloud security, disaster recovery, and continuity of business.

CCI's bachelor degree programs in Computing and Security Technology, Data Science (p. 31), and Information Systems (p. 42) share a common first year. This allows students to easily switch among the degrees early in their studies. In addition, some of the electives in each degree are accessible to students in the other two majors; this provides a deeper and broader set of advanced topics for students in all three majors.

The BS in Computing and Security Technology is offered as a full-time, on-campus bachelor's degree program or as an online, part-time degree completion program for students who have completed approximately two years of college work.

Additional Information

For more information about this program, please visit the BS in Computing & Security Technology webpage (https://drexel.edu/cci/academics/undergraduate-programs/bs-computing-security/) on the College of Computing & Informatics website.

Degree Requirements

Students completing this major must select either a concentration in Computing Technology or a concentration in Computing Security.

Computing & Security Technology Core Requirements		
CT 140	Network Administration I	3.0
CT 200	Server I	3.0
CT 201	Information Technology Security I	3.0
CT 210	Open Server I	3.0
CT 301	Information Technology Security II	3.0
CT 310	Open Server II	3.0
CT 320	Server II	3.0
CT 330	Network Administration II	3.0
Students completing this major must select either a concentration in Computing Technology or a concentration in Computing Security. see below		21.0
Information Science Requirements		
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 102	Introduction to Information Systems	3.0
INFO 103	Introduction to Data Science	3.0
INFO 200	Systems Analysis I	3.0
INFO 210	Database Management Systems	3.0
INFO 215	Social Aspects of Information Systems	3.0
INFO 310	Human-Centered Design Process & Methods	3.0
INFO 324 [WI]	Team Process and Product	3.0
INFO 355	Systems Analysis II	3.0
INFO 365	Database Administration I	3.0
INFO 420	Software Project Management	3.0
Programming Requirements		**9.0**
Choose one of the following sequences		
INFO 151 & CS 171 & CS 172	Web Systems and Services I and Computer Programming I and Computer Programming II	
INFO 151 & INFO 152 & INFO 153	Web Systems and Services I and Web Systems and Services II and Applied Data Management	

Computing & Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CT 491 [WI]	Senior Project I	3.0
CT 496 [WI]	Senior Project II	3.0
CCI elective *		6.0
Mathematics Requirements		
Choose Mathematics Sequence		8.0
If a Math seqence of 8 credits is taken, additional 1 credits added to free electives		
MATH 171 & MATH 172 & MATH 173	Introduction to Analysis A and Introduction to Analysis B and Introduction to Analysis C	
MATH 121 & MATH 122	Calculus I and Calculus II	
MATH 180	Discrete Computational Structures	4.0
STAT 201	Introduction to Business Statistics	4.0
Natural Science Requirements **		**8.0**
Liberal Studies Requirements		
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
COM 230	Techniques of Speaking	3.0
Liberal Studies Electives ***		12.0
University Requirements		
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development	1.0
Free Electives		**28.0**
Total Credits		**185.0**

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One course must be a CCI 300 level or higher course.

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Students select any non-required courses from the following: ANAT, BIO, CHEM, ENVS, FDSC, NFS, PHEV, PHYS, HSCI, GEO, ENSS.

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Students select any non-required courses from the following: ANTH, COM, ENGL, HIST, PHIL, PSCI, PSY, SOC, WRIT, ECON, ENTP, ARTH, FMST, MUSC, TVST, VSST

Please note: If a Computing & Security Technology student pursues a Business Administration Minor, MIS classes do not count towards the Business Administration Minor for Computing & Security Technology students. Students must choose another option to fulfill the Business Administration Minor requirements.

Concentration in Computing Technology

Computing Technology Concentration Requirements		
CT 335	Mobile Applications	3.0
CT 353	Virtual Environments and Cloud Security	3.0
CT 355	Wireless Network Security Technology	3.0
CT 415	Disaster Recovery and Continuity Planning	3.0
INFO 366	Database Administration II	3.0
Computing Technology Electives		
Select two of the following:		6.0
CT 362	Network Auditing Tools	
CT 393	Information Technology Security Risk Assessment	
CT 412	Information Technology Security Policies	

INFO 315	Advanced Database Management Systems	
Total Credits		**21.0**

Concentration in Computing Security

Computing Security Concentration Requirements		
CT 212	Computer Forensics I: Fundamentals	3.0
CT 312	Access Control and Intrusion Detection Technology	3.0
CT 400	Network Security	3.0
CT 412	Information Technology Security Policies	3.0
CT 432	Information Technology Security Systems Audits	3.0
Computing Security Electives		
Select two of the following:		6.0
CT 250	IT Security Awareness	
CT 382	Applied Cryptography	
CT 393	Information Technology Security Risk Assessment	
CT 414	Ethical Hacking and Penetration Testing	
CT 415	Disaster Recovery and Continuity Planning	
Total Credits		**21.0**

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Concentrations: Sample Plans of Study

Computing Security Concentration

4-Year, 1 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	ENGL 102 or 112	3.0	INFO 103	3.0		
INFO 151	3.0	INFO 102	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 152 or CS 171	3.0	MATH 173	3.0		
UNIV CI101	1.0	MATH 172	3.0	UNIV CI101	1.0		
	15		**15**		**15**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP 101*	1.0	CT 310	3.0	CT 200	3.0	CT 301	3.0
CT 140	3.0	CT 330	3.0	CT 201	3.0	CT 320	3.0
CT 210	3.0	INFO 210	3.0	CT 212	3.0	INFO 355	3.0
INFO 200	3.0	STAT 201	4.0	MATH 180	4.0	Liberal Studies Elective	3.0
INFO 215	3.0	Free Elective	3.0	Science Elective I	4.0	Science Elective II	4.0
Free Elective	3.0						
	16		**16**		**17**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		COM 230	3.0	CT 412	3.0
				CT 312	3.0	INFO 324	3.0
				INFO 310	3.0	INFO 420	3.0

				INFO 365	3.0	Computing Security Elective	3.0
				Liberal Studies Elective	3.0	Free Elective	3.0
	0		**0**		**15**		**15**

Fourth Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**
CT 400	3.0	CT 432	3.0	CT 496	3.0
CCI Elective	3.0	CT 491	3.0	CCI Elective	3.0
Computing Security Elective	3.0	Free Electives	9.0	Free Elective	6.0
Free Elective	3.0			Libral Studies Elective	3.0
Liberal Studies Elective	3.0				
	15		**15**		**15**

Total Credits 185

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COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

5-Year, 3 co-ops

First Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	COOP 101*	1.0	INFO 103	3.0		
INFO 151	3.0	ENGL 102 or 112	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 102	3.0	MATH 173	3.0		
UNIV CI101	1.0	INFO 152 or CS 171	3.0	UNIV CI101	1.0		
		MATH 172	3.0				
	15		**16**		**15**		**0**

Second Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		CT 140	3.0	CT 310	3.0
				CT 210	3.0	CT 330	3.0
				INFO 200	3.0	INFO 210	3.0
				INFO 215	3.0	STAT 201	4.0
				Free Elective	3.0	Free Elective	3.0
				MATH 180	4.0		
	0		**0**		**19**		**16**

Third Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		CT 200	3.0	CT 301	3.0
				CT 201	3.0	CT 320	3.0
				CT 212	3.0	INFO 355	3.0
				Liberal Studies Elective	3.0	Free Elective	3.0
				Science Elective I	4.0	Science Elective II	4.0
	0		**0**		**16**		**16**

Fourth Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		COM 230	3.0	CT 412	3.0
				CT 312	3.0	INFO 324	3.0
				INFO 310	3.0	INFO 420	3.0
				INFO 365	3.0	Computing Security Elective	3.0
				Liberal Studies Elective	3.0	Free Elective	3.0
	0		**0**		**15**		**15**

Fifth Year

Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**
CT 400	3.0	CT 432	3.0	CT 496	3.0
CCI Elective	3.0	CT 491	3.0	CCI Elective	3.0
Computing Security Elective	3.0	Free Electives	9.0	Free Electives	3.0

Free Elective	3.0	Liberal Studies Elective	3.0
Liberal Studies Elective	3.0		
	15	**15**	**12**

Total Credits 185

*

COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Computing Technology Concentration

4-Year, 1 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	CS 171	3.0	INFO 103	3.0		
INFO 151	3.0	ENGL 102 or 112	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 102	3.0	MATH 173	3.0		
UNIV CI101	1.0	MATH 172	3.0	UNIV CI101	1.0		
	15		**15**		**15**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP 101*	1.0	CT 301	3.0	CT 200	3.0	CT 310	3.0
CT 140	3.0	CT 330	3.0	CT 210	3.0	CT 320	3.0
CT 201	3.0	INFO 210	3.0	CT 335	3.0	INFO 355	3.0
INFO 200	3.0	STAT 201	4.0	MATH 180	4.0	Liberal Studies Elective	3.0
INFO 215	3.0	Free Elective	3.0	Science Elective I	4.0	Science Elective II	4.0
Free Elective	3.0						
	16		**16**		**17**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		COM 230	3.0	INFO 324	3.0
				INFO 310	3.0	INFO 366	3.0
				INFO 365	3.0	INFO 420	3.0
				Computing Technology Elective	3.0	Free Electives	6.0
				Liberal Studies Elective	3.0		
	0		**0**		**15**		**15**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
CT 355	3.0	CT 362	3.0	CT 415	3.0
CCI Elective	3.0	CT 491	3.0	CT 496	3.0
Liberal Studies Elective	3.0	Computing Technology Elective	3.0	Free Electives	6.0
Free Electives	6.0	Free Electives	6.0	Liberal Studies Elective	3.0
	15		**15**		**15**

Total Credits 185

*

COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

5-Year, 1 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	COOP 101*	1.0	INFO 103	3.0		
INFO 151	3.0	ENGL 102 or 112	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 102	3.0	MATH 173	3.0		
UNIV CI101	1.0	INFO 152 or CS 171	3.0	UNIV CI101	1.0		

		MATH 172	3.0				
	15		**16**		**15**		**0**
Second Year							
Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		CT 140	3.0	CT 301	3.0
				CT 201	3.0	CT 330	3.0
				INFO 200	3.0	INFO 210	3.0
				INFO 215	3.0	STAT 201	4.0
				Free Elective	3.0	Free Elective	3.0
				MATH 180	4.0		
	0		**0**		**19**		**16**
Third Year							
Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		CT 200	3.0	CT 310	3.0
				CT 210	3.0	CT 320	3.0
				CT 335	3.0	INFO 355	3.0
				Liberal Studies Elective	3.0	Free elective	3.0
				Science Elective I	4.0	Science Elective II	4.0
	0		**0**		**16**		**16**
Fourth Year							
Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**	**Summer**	**Credits**
COOP EXPERIENCE		COOP EXPERIENCE		COM 230	3.0	INFO 324	3.0
				INFO 310	3.0	INFO 366	3.0
				INFO 365	3.0	INFO 420	3.0
				Computing Technology Elective	3.0	Free Electives	6.0
				Liberal Studies Elective	3.0		
	0		**0**		**15**		**15**
Fifth Year							
Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**		
CT 355	3.0	CT 362	3.0	CT 415	3.0		
CCI Elective	6.0	CT 491	3.0	CT 496	3.0		
Liberal Studies Elective	3.0	Computing Technology Elective	3.0	Free Elective	3.0		
Free Elective	3.0	Free Electives	6.0	Liberal Studies Elective	3.0		
	15		**15**		**12**		

Total Credits 185

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COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-Op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

Co-op is not available for online students.

Career Opportunities

Graduates of the Computing and Security Technology program who complete a concentration in Computing Technology can pursue careers as information technologists and advanced technicians in a wide range of industries. Information technologists are capable of performing multiple IT tasks and accessing various information resources. The program gives students a unique set of applied skills that allow them to fill a number of roles as part of an information systems team. Graduates with a concentration in Computing Security pursue careers as advanced technicians who operate and administer the security tools, technologists who create and install security solutions, and leaders who define the security policies.

Job titles of recent computing and security technology graduates include:

- Security Administrator
- Chief Information Security Officer
- IT Audit Manager
- Project Manager
- Lead Systems Engineer
- Network Engineer
- Server Engineer

Additional Information

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more information on career opportunities.

Facilities

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)
- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center
- Adjacent to future public square
- Access to Science Center’s nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries’ various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons’ Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's fully equipped conference room with 42” displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching” platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University’s network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory
- Over 556 TB of HDD-backed storage
- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College’s research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the Computing and Security Technology degree is evaluated relative to the following Objectives and Outcomes.

BS Computing and Security Technology Program Educational Objectives

Within three to five years of graduating, alumni of the program are expected to achieve one or more of the following milestones:

- Be valued contributors to private or public organizations as demonstrated by promotions, increased responsibility, or other professional recognition
- Contribute to professional knowledge as demonstrated by published papers, technical reports, patents, or conference presentations
- Succeed in continuing professional development as demonstrated by completion of graduate studies or professional certifications

- Display commitment and leadership within the profession and community as demonstrated by contributions towards society's greater good and prosperity

BS Computing and Security Technology Program Student Outcomes

The program enables students to attain by the time of graduation:

- An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security and social issues and responsibilities
- An ability to communicate effectively with a range of audiences
- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice

Data Science BSDS

Major: Data Science
Degree Awarded: Bachelor of Science in Data Science (BSDS)
Calendar Type: Quarter
Minimum Required Credits: 183.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Programs (CIP) code: 30.7001
Standard Occupational Classification (SOC) code: *11-3021; 15-1221; 15-1243; 15-2041; 15-2051*

About the Program

The Bachelor of Science in Data Science (BSDS) prepares students to meet the challenges presented by the explosive growth of very large scale and complex data sources. The availability of data from sources such as business activities, social media, and scientific instruments constantly creates new problems requiring data-driven solutions and opportunities and problems for innovation. BS in Data Science students develop the knowledge and skill to address these opportunities for the benefit of individuals and organizations. Students in the degree complete a minor, typically in business or the sciences, to provide knowledge and skill in a specific subject area to which data science techniques can be applied.

Data Science students learn to:

- Define domain specific and context-relevant data analytics questions and hypotheses for individuals and organizations
- Select relevant data sources and transform data suitable for solving data analytics problems
- Identify appropriate techniques and tools for acquiring, retrieving, analyzing, and making use of the data
- Apply data analytics techniques and skills to build analytical and predictive models for answering data science questions
- Create visualizations and communicate data analytics results to stakeholders and decision-makers
- Assess the necessary skills arising from the interdisciplinary nature of data science as a combination of hacking skills, analytical techniques, and domain knowledge

The degrees in Computing and Security Technology (p. 22), Data Science, and Information Systems (p. 42) share a common first year. This allows students to easily switch among the degrees early in their studies. In addition, some of the electives in each degree are accessible to students in the other two majors; this provides a deeper and broader set of advanced topics for students in all three majors.

Additional Information

For more information about this program, please visit the BS in Data Science webpage (https://drexel.edu/cci/academics/undergraduate-programs/bs-datascience/) on the College of Computing & Informatics website.

Degree Requirements

Data Science Requirements		
DSCI 351	Recommender Systems	3.0
DSCI 471	Applied Deep Learning	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 102	Introduction to Information Systems	3.0
INFO 103	Introduction to Data Science	3.0

INFO 202	Data Curation	3.0
INFO 210	Database Management Systems	3.0
or CS 461	Database Systems	
INFO 212	Data Science Programming I	3.0
INFO 213	Data Science Programming II	3.0
INFO 215	Social Aspects of Information Systems	3.0
INFO 250	Information Visualization	3.0
INFO 323	Cloud Computing and Big Data	3.0
INFO 332	Exploratory Data Analytics	3.0
INFO 432	Advanced Data Analytics	3.0
INFO 440	Social Media Data Analysis	3.0
INFO 442	Data Science Projects	3.0
CCI Electives		**6.0**
Select 2 CCI courses (CI, CS, CT, DSCI, INFO, SE) that are at 200 or above level and not otherwise required		
Data Science Electives		**6.0-7.0**
Select 2 of the following courses:		
CS 260	Data Structures	
CS 270	Mathematical Foundations of Computer Science	
CS 380	Artificial Intelligence	
CS 383	Machine Learning	
INFO 200	Systems Analysis I	
INFO 300	Information Retrieval Systems	
INFO 315	Advanced Database Management Systems	
INFO 355	Systems Analysis II	
INFO 420	Software Project Management	
Computing and Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Introductory Programming		
CS 171	Computer Programming I	3.0
CS 172	Computer Programming II	3.0
CS 265	Advanced Programming Tools and Techniques	3.0
Mathematics Requirements		
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 180	Discrete Computational Structures	4.0
MATH 201	Linear Algebra	4.0
Statistics Requirements		
STAT 201	Introduction to Business Statistics	4.0
STAT 202	Business Statistics II	4.0
Natural Science Requirements		
Science electives: Select from ANAT, BIO, CHEM, ENVS, FDSC, NFS, PHEV, PHYS. Courses from other departments may be considered with advisor approval.		8.0
Arts and Humanities Requirements		
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
COM 230	Techniques of Speaking	3.0
or COM 310	Technical Communication	
Arts & Humanities, Business, or Social Studies electives (see below) ***		6.0
University and College Requirements		
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development **	1.0
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
Minor Requirements *		**24.0**

Choose a minor in a data science application area including business and natural science	
Free Electives	**21.0**
Total Credits	**183.0-184.0**

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Students should consult their academic advisor regarding a minor that requires more than 24.0 credits. *Please note:* If a Business Administration Minor is selected, MIS classes do not count towards the Business Administration Minor for Data Science students. Students must choose another option to fulfill the Business Administration Minor requirements.

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COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

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Arts & Humanities, Business, or Social Studies Electives (Exclude: courses that are counted as other requirements and electives)**:**

- **Business electives**: any ACCT, BLAW, BUSN, ECON, ENTP, FIN, HRMT, INTB, MGMT, MIS, MKTG, OPM, OPR, ORGB, STAT, TAX
- **Social Studies electives**: any AFAS, ANTH, GST, HIST, JWST, PSCI, PSY, SOC, WGST
- **Arts & Humanities electives**: any ARCH, ARTH, CMGT, CJS, COM, CULA, DANC, EDEX, EDUC, ENGL (except ENGL 101 (http://catalog.drexel.edu/search/?P=ENGL%20101), ENGL 102 (http://catalog.drexel.edu/search/?P=ENGL%20102), ENGL 103 (http://catalog.drexel.edu/search/?P=ENGL%20103), ENGL 105 (http://catalog.drexel.edu/search/?P=ENGL%20105), ENGL 111 (http://catalog.drexel.edu/search/?P=ENGL%20111), ENGL 112 (http://catalog.drexel.edu/search/?P=ENGL%20112), ENGL 113 (http://catalog.drexel.edu/search/?P=ENGL%20113)), ESTM, FASH, FMST, FMVD, GST, INTR, LING, MUSC, PHIL, PHTO, THTR, VSCM, VSST, WRIT, Foreign Language courses (http://www.drexel.edu/culturecomm/academics/undergraduate/modernlang/languages/) as defined by the College of Arts and Sciences, and GMAP 260 (http://catalog.drexel.edu/search/?P=GMAP%20260), ANIM 140 (http://catalog.drexel.edu/search/?P=ANIM%20140), ANIM 141 (http://catalog.drexel.edu/search/?P=ANIM%20141), ANIM 211 (http://catalog.drexel.edu/search/?P=ANIM%20211), ANIM 212 (http://catalog.drexel.edu/search/?P=ANIM%20212)

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

5 year, 3 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	CS 172	3.0		
INFO 101	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171	3.0	INFO 103	3.0		
UNIV CI101	1.0	ENGL 102 or 112	3.0	MATH 180	4.0		
Arts, Humanities, Business, Social Studies Electives	3.0	INFO 102	3.0	UNIV CI101	1.0		
		MATH 122	4.0				
	16		**17**		**16**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		INFO 202	3.0	CS 265	3.0
				INFO 210 or CS 461	3.0	INFO 215	3.0
				INFO 212	3.0	INFO 250	3.0
				STAT 201	4.0	MATH 201	4.0

						STAT 202	4.0
	0		**0**		**13**		**17**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		COM 230 or 310	3.0	DSCI 351	3.0
				INFO 213	3.0	INFO 440	3.0
				INFO 323	3.0	Arts, Humanities, Business, Social Studies Electives	3.0
				Free Elective	3.0	Data Science Elective	3.0
				Science Elective	4.0	Science Elective	4.0
	0		**0**		**16**		**16**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		DSCI 471	3.0	INFO 432	3.0
				INFO 332	3.0	INFO 442	3.0
				Data Science Elective	3.0	CCI Elective	3.0
				Free Elective	3.0	Minor Electives	6.0
				Minor Elective	3.0		
	0		**0**		**15**		**15**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
Free Electives	3.0	CCI Elective	3.0	Free Electives	6.0
Minor Electives	6.0	Free Electives	6.0	Minor Electives	6.0
		Minor Elective	3.0		
	12		**15**		**15**

Total Credits 183

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COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

4 year, 1 co-op

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	CS 172	3.0		
INFO 101	3.0	CS 171	3.0	ENGL 103 or 113	3.0		
MATH 121	4.0	ENGL 102 or 112	3.0	INFO 103	3.0		
UNIV CI101	1.0	INFO 102	3.0	MATH 180	4.0		
Arts, Humanities, Business, Social Studies Electives	3.0	MATH 122	4.0	UNIV CI101	1.0		
	16		**16**		**16**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	INFO 215	3.0	COM 230 or 310	3.0	DSCI 351	3.0
COOP 101*	1.0	INFO 250	3.0	INFO 213	3.0	INFO 440	3.0
INFO 202	3.0	MATH 201	4.0	INFO 323	3.0	Arts, Humanities, Business, Social Studies Electives	3.0
INFO 210 or CS 461	3.0	STAT 202	4.0	Free Elective	3.0	Data Science Elective	3.0
INFO 212	3.0			Science Elective	4.0	Science Elective	4.0
STAT 201	4.0						
	17		**14**		**16**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		DSCI 471	3.0	INFO 432	3.0
				INFO 332	3.0	INFO 442	3.0
				Data Science elective	3.0	CCI Elective	3.0
				Free Elective	3.0	Minor Elective	6.0

			Minor Elective	3.0	
	0		**0**	**15**	**15**
Fourth Year					
Fall	**Credits**	**Winter**	**Credits**	**Spring**	**Credits**
CI 491	3.0	CI 492	3.0	CI 493	3.0
Free Electives	3.0	CCI Elective	3.0	Free Electives	6.0
Minor Electives	6.0	Free Electives	6.0	Minor Electives	6.0
		Minor Electives	3.0		
	12		**15**		**15**

Total Credits 183

*****

COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

Career Opportunities

The Data Science major provides valuable skills that can be transported to a number of job settings. The demand for graduates with data science knowledge is strong, and employers often want evidence of additional communication and problem-solving skills that can be applicable to specific disciplines. Data Science program graduates could potentially serve as key members of organizational data science teams able to create novel information products, with an emphasis on solving problems that can only be addressed using large and disparate data sources. The program is also an excellent preparation for graduate study in data science.

Sample job titles for data science graduates include:

- Data Scientist
- Business Intelligence Officer
- Information Architect
- Usability Analyst

Additional Information

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more detailed information on co-op and post-graduate opportunities.

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)
- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center
- Adjacent to future public square
- Access to Science Center’s nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries' various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons' Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's fully equipped conference room with 42" displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching" platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University's network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory
- Over 556 TB of HDD-backed storage

- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College's research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the Data Science degree is evaluated relative to the following Objectives and Outcomes.

BS Data Science Program Educational Objectives

Within three to five years of graduation, alumni of the program are expected to achieve one or more of the following milestones:

- Be valued contributors to private or public organizations as demonstrated by promotions, increased responsibility, or other professional recognition
- Contribute to professional knowledge as demonstrated by published papers, technical reports, patents, or conference presentations
- Succeed in continuing professional development as demonstrated by completion of graduate studies or professional certifications
- Display commitment and leadership within the professional and community as demonstrated by contributions towards society's greater good and prosperity

BS Data Science Program Student Outcomes

The program enables students to attain by the time of graduation

- An ability to apply knowledge of computing and mathematics appropriate to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security, and social issues
- An ability to communicate effectively with a range of audiences
- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice

Economics and Data Science BS

Major: Economics and Data Science
Degree Awarded: Bachelor of Science (BS)
Calendar Type: Quarter
Minimum Required Credits: 180.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Programs (CIP) code: 30.3901
Standard Occupational Classification (SOC) code: 15-2041, 15-2051, 19-3011, 11-9199

About the Program

The STEM-designated Economics and Data Science is an interdisciplinary major that prepares students to work in an economy that has been transformed by the emergence of digital commerce and massive amounts of data. Coursework in data science teaches students how to manage, manipulate, and parse data to extract knowledge and insight.

Through the study of economics, students learn how the design of platforms shapes incentives, drives behavior, and determines social and economic outcomes including equity and efficiency. Students also learn how data may be used for predictive or causal analysis to inform business decisions or public policy.

The program provides excellent training for careers in the digital economy, including areas such as insurance, consulting, finance, retailing, and government. It also provides outstanding preparation for graduate study in business, data science, public health, economics, or other social sciences.

Additional Information

For more information please contact our LeBow College Undergraduate Advising department at lebowadv@drexel.edu (lebowgradenroll@drexel.edu) or the College of Computing & Informatics at cciinfo@drexel.edu

Degree Requirements

University Requirements		
UNIV B101	The Drexel Experience	1.0
or UNIV CI101	The Drexel Experience	
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development *	1.0
UNIV B201 [WI]	Career Management	1.0
General Education Requirements		
English Requirements		
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
Communications Requirement		
COM 230	Techniques of Speaking	3.0
Mathematics and Statistics		
**Select one of the following sequences: ** **		
MATH 101 & MATH 102 & MATH 180 & MATH 201	Introduction to Analysis I and Introduction to Analysis II and Discrete Computational Structures and Linear Algebra	16.0-18.0
or MATH 105 & MATH 121 & MATH 180 & MATH 201	Algebra, Functions, and Trigonometry and Calculus I and Discrete Computational Structures and Linear Algebra	
or MATH 116 & MATH 117 & MATH 180 & MATH 201	Calculus and Functions I and Calculus and Functions II and Discrete Computational Structures and Linear Algebra	
STAT 201	Introduction to Business Statistics	4.0
or MATH 311	Probability and Statistics I	
STAT 202	Business Statistics II	4.0
or MATH 312	Probability and Statistics II	
Computer Science		
CS 150	Computer Science Principles	3.0
or CS 164	Introduction to Computer Science	
CS 171	Computer Programming I	3.0
CS 172	Computer Programming II	3.0
Economics Requirements		
ECON 201	Principles of Microeconomics	4.0
ECON 202	Principles of Macroeconomics	4.0
ECON 250	Game Theory and Applications	4.0
ECON 270	Using Big Data to Solve Economic and Social Problems	4.0
ECON 301	Microeconomics	4.0

ECON 321	Macroeconomics	4.0
ECON 322 [WI]	Economics Seminar	4.0
ECON 350 [WI]	Applied Econometrics	4.0
ECON 360	Time Series Econometrics	4.0
or ECON 370	Experiments and Causality in Economics	
Data Science Requirements		
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
DSCI 351	Recommender Systems	3.0
DSCI 471	Applied Deep Learning	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 103	Introduction to Data Science	3.0
INFO 210	Database Management Systems	3.0
INFO 212	Data Science Programming I	3.0
INFO 213	Data Science Programming II	3.0
INFO 250	Information Visualization	3.0
INFO 323	Cloud Computing and Big Data	3.0
INFO 332	Exploratory Data Analytics	3.0
INFO 440	Social Media Data Analysis	3.0
INFO 442	Data Science Projects	3.0
Economics Electives		
Select 12 credits from the following		12.0
ECON 203 [WI]	Survey of Economic Policy	
ECON 248	Mathematical Models in Economics	
ECON 260	Economics of Small Business	
ECON 324	Economics of Happiness	
ECON 326 [WI]	Economic Ideas	
ECON 330	Managerial Economics	
ECON 331	International Macroeconomics	
ECON 334	Public Finance	
ECON 336	Labor Economics	
ECON 338	Industrial Organization	
ECON 342	Economic Development	
ECON 344	Comparative Economic Systems	
ECON 348	Mathematical Economics	
ECON 351	Resource and Environmental Economics	
ECON 354	Money and Banking	
ECON 360	Time Series Econometrics	
ECON 361	Health Economics	
ECON 365	Behavioral Economics	
ECON 366	Topics in Behavioral Economics	
ECON 370	Experiments and Causality in Economics	
ECON 380	Economic Crises: The American Experience	
ECON T480	Special Topics in Economics	
INTB 332	Multinational Corporations	
INTB 334	International Trade	
INTB 336	International Money and Finance	
INTB 338	Regional Studies in Economic Policies and International Business	
INTB 440	Seminar in International Business	
SMT 320	Sport Economics	
Data Science Electives		
Select 6 credits from the following courses		6.0
CS 270	Mathematical Foundations of Computer Science	
CS 380	Artificial Intelligence	
CS 383	Machine Learning	
INFO 315	Advanced Database Management Systems	
INFO 371	Data Mining Applications	
INFO 432	Advanced Data Analytics	
Free Electives		34.0
Total Credits		**180.0-182.0**

*

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

**

Students should speak with an advisor about their math placement. Students who place out of the first math course in a sequence will have additional credits of free electives. Some students who select the MATH 116 & MATH 117 sequence may need a one-credit concurrent practicum course depending on their calculus exam score and summer preparatory review participation.

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

5 Year 3 Coop

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CIVC 101	1.0	COOP 101*	1.0	CS 150 or 164	3.0	VACATION	
ECON 201	4.0	ECON 202	4.0	ENGL 103 or 113	3.0		
ENGL 101 or 111	3.0	ECON 270	4.0	INFO 103	3.0		
INFO 101	3.0	ENGL 102 or 112	3.0	MATH 201 or 180	4.0		
UNIV B101 or CI101	1.0	MATH 102, 121, 117, or 201	4.0				
MATH 101, 105, 116, or 121	4.0-6.0						
	16-18		**16**		**13**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		CS 171	3.0	COM 230	3.0
				ECON 301	4.0	CS 172	3.0
				INFO 210	3.0	ECON 250	4.0
				STAT 201 or MATH 311	4.0	STAT 202 or MATH 312	4.0
				MATH 180†	4.0		
	0		**0**		**18**		**14**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		CS 265	3.0	CS 260	4.0
				ECON 321	4.0	INFO 213	3.0
				ECON 350	4.0	INFO 250	3.0
				INFO 212	3.0	ECON Elective	4.0
				INFO 440	3.0		
	0		**0**		**17**		**14**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		DSCI 351	3.0	DSCI 471	3.0
				INFO 323	3.0	INFO 332	3.0
				ECON Elective	4.0	Free Elective	8.0
				Free Elective	4.0		
	0		**0**		**14**		**14**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
ECON 360 or 370	4.0	UNIV B201	1.0	ECON 322	4.0
Free Electives	7.0	Data Science Elective	3.0	INFO 442	3.0
Data Science Elective	3.0	ECON Elective	4.0	Free Elective	8.0
		Free Elective	7.0		
	14		**15**		**15**

Total Credits 180-182

*

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 (http://catalog.drexel.edu/search/?P=COOP%20101) registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 (http://catalog.drexel.edu/search/?P=COOP%20001) in place of COOP 101 (http://catalog.drexel.edu/search/?P=COOP%20101).

†

Students who placed out of the first course in their math sequence will have additional credits of free electives.

4 Year 1 Coop

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
UNIV B101 or CI101	1.0	ENGL 102 or 112	3.0	ENGL 103 or 113	3.0	VACATION	
CIVC 101	1.0	ECON 202	4.0	CS 150 or 164	3.0		
ENGL 101 or 111	3.0	MATH 102, 121, 117, or 201	4.0	MATH 201 or 180	4.0		
INFO 101	3.0	ECON 270	4.0	INFO 103	3.0		
MATH 101, 105, 116, or 121	4.0-6.0			Free Elective	3.0		
ECON 201	4.0						
	16-18		**15**		**16**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 171	3.0	CS 172	3.0	ECON 350	4.0	INFO 213	3.0
STAT 201 or MATH 311	4.0	ECON 321	4.0	COM 230	3.0	INFO 250	3.0
ECON 301	4.0	STAT 202 or MATH 312	4.0	INFO 212	3.0	CS 260	4.0
INFO 210	3.0	COOP 101	1.0	CS 265	3.0	Free Electives	6.0
MATH 180†	4.0						
	18		**12**		**13**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		ECON 370 or 360	4.0	ECON 250	4.0
				INFO 323	3.0	INFO 332	3.0
				INFO 440	3.0	Free Electives	7.0
				Econ Elective	4.0		
	0		**0**		**14**		**14**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
UNIV B201	1.0	DSCI 351	3.0	DSCI 471	3.0
ECON 322	4.0	Data Science Elective	3.0	INFO 442	3.0
Econ Elective	4.0	Econ Elective	4.0	Free Electives	9.0
Data Science Elective	3.0	Free Electives	6.0		
Free Elective	3.0				
	15		**16**		**15**

Total Credits 180-182

*

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 (http://catalog.drexel.edu/search/?P=COOP%20101) registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 (http://catalog.drexel.edu/search/?P=COOP%20001) in place of COOP 101 (http://catalog.drexel.edu/search/?P=COOP%20101).

†
Students who placed out of the first course in their math sequence will have additional credits of free electives.

Information Systems BSIS

Major: Information Systems
Degree Awarded: Bachelor of Science in Information Systems (BS)
Calendar Type: Quarter
Minimum Required Credits: 185.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Programs (CIP) code: 11.0401
Standard Occupational Classification (SOC) code: 11-3021

About the Program

The College of Computing & Informatics' Bachelor of Science in Information Systems (BSIS) prepares students to apply information technology for the benefit of individuals and organizations. Students develop the skills and knowledge to design, develop, and manage leading-edge information systems. Since many Information Systems students choose careers in business organizations, a minor in business is built into the degree requirements.

The Information Systems curriculum prepares students for a wide range of information technology applications. Students learn how to determine client needs, design appropriate solutions, specify data architectures, and improve the usability of systems.

The core courses in the program address topics including fundamentals of programming, systems analysis and design, database management systems, networking, security and privacy, and social aspects of information systems. These courses provide a foundation for more advanced courses in technical areas of interest to each student. The technical courses are supplemented by courses in business, behavioral sciences, natural sciences, mathematics, and the humanities to provide balance and useful supplemental materials for information systems careers.

The BSIS has four (4) core competencies students will have mastered upon graduation. The core competencies are supported by three (3) courses in each area.

- Requirements and Design

1. INFO 200 *Systems Analysis I*
2. INFO 324 [WI] *Team Process and Product*
3. INFO 355 *System Analysis II*

- Database and Information Management

1. INFO 210 *Database Management Systems*
2. INFO 315 *Advanced Database Management Systems*
3. INFO 371 *Data Mining Applications*

- User Experience

1. INFO 150 *Introduction to Ubiquitous Computing*
2. INFO 310 *Human-Centered Design Process & Methods*
3. INFO 405 *Social and Collaborative Computing*

- Security and Assurance

1. CT 201 *Information Technology Security I*
2. CT 250 *IT Security Awareness*
3. INFO 375 *Introduction to Information Systems Assurance*

The degrees in Computing and Security Technology (p. 22), Data Science (p. 31), and Information Systems share a common first year. This allows students to easily switch among the degrees early in their studies. In addition, some of the electives in each degree are accessible to students in the other two majors, and this provides a deeper and broader set of advanced topics for students in all three majors.

Additional Information

For more information about this program, please visit the BS in Information Systems webpage (https://drexel.edu/cci/academics/undergraduate-programs/bs-information-systems/) on the College of Computing & Informatics website.

Degree Requirements

Information Systems Requirements		
CT 140	Network Administration I	3.0
CT 201	Information Technology Security I	3.0
CT 250	IT Security Awareness	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 102	Introduction to Information Systems	3.0
INFO 103	Introduction to Data Science	3.0
INFO 150	Introduction to Ubiquitous Computing	3.0
INFO 200	Systems Analysis I	3.0
INFO 210	Database Management Systems	3.0
INFO 215	Social Aspects of Information Systems	3.0
INFO 310	Human-Centered Design Process & Methods	3.0
INFO 315	Advanced Database Management Systems	3.0
INFO 324 [WI]	Team Process and Product	3.0
INFO 355	Systems Analysis II	3.0
INFO 371	Data Mining Applications	3.0
INFO 375	Introduction to Information Systems Assurance	3.0
INFO 405	Social and Collaborative Computing	3.0
INFO 420	Software Project Management	3.0
INFO/CT Electives *		12.0
Programming Requirements		**9.0**
Choose one of the following sequences		
INFO 151 & CS 171 & CS 172	Web Systems and Services I and Computer Programming I and Computer Programming II	
INFO 151 & INFO 152 & INFO 153	Web Systems and Services I and Web Systems and Services II and Applied Data Management	
Computing and Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Business or IS Environment Minor Requirements **		**24.0**
Mathematics Requirements		
Choose 1 of the following sequences:		9.0
If sequence less than 9.0 credits, add additional 1.0 credit to free electives		
MATH 171 & MATH 172 & MATH 173	Introduction to Analysis A and Introduction to Analysis B and Introduction to Analysis C	
MATH 121 & MATH 122	Calculus I and Calculus II	
MATH 180	Discrete Computational Structures	4.0
STAT 201	Introduction to Business Statistics	4.0
Natural Science Requirements		
Select 8.0 credits from any non-required courses from the following: ANAT, BIO, CHEM, ENVS, FDSC, NFS, PHEV, PHYS, HSCI, GEO, ENSS		8.0
Liberal Studies Requirements		
COM 230	Techniques of Speaking	3.0
or COM 310	Technical Communication	
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
Select any non-required courses from ANTH, COM, ENGL, HIST, PHIL, PSCI, PSY, SOC, WRIT, ECON, ENTP, ARTH, FMST, MUSC, TVST, VSST		6.0
University and College Requirements		
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development	1.0

UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
Free Electives		**24.0**
Total Credits		**185.0**

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Any non-required INFO or CT course

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Minor Requirements:
Students must complete the requirements for a minor in an information systems application area. The following minors are approved for this requirement:

- College of Business minors – Note: the MIS minor cannot be used for this requirement due to its considerable overlap with the IS major
- Close School of Entrepreneurship minors
- School of Public Health minors
- Other minors in IS application areas may be taken for this requirement with prior approval of an advisor

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

5 YR UG Co-op Concentration

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	COOP 101*	1.0	INFO 103	3.0		
INFO 151	3.0	ENGL 102 or 112	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 102	3.0	MATH 173	3.0		
UNIV CI101	1.0	INFO 152 or CS 171	3.0	UNIV CI101	1.0		
		MATH 172	3.0				
	15		**16**		**15**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		CT 201	3.0	INFO 210	3.0
				INFO 150	3.0	STAT 201	4.0
				INFO 200	3.0	Free Elective	3.0
				INFO 215	3.0	INFO Elective	3.0
				MATH 180	4.0	Liberal Studies Elective	3.0
	0		**0**		**16**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		COM 230 or 310	3.0	CT 140	3.0
				INFO 315	3.0	CT 250	3.0
				INFO 324	3.0	INFO 310	3.0
				INFO 371	3.0	Liberal Studies Elective	3.0
				INFO 375	3.0	Minor Elective	4.0
	0		**0**		**15**		**16**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		INFO 355	3.0	INFO 420	3.0
				Free Elective	6.0	Minor Electives	8.0
				Minor Elective	4.0	Science Sequence Course 2*	4.0
				Science Sequence Course 1*	4.0		
	0		**0**		**17**		**15**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
INFO 405	3.0	Free Electives	4.0	Free Electives	12.0
INFO Electives	6.0	INFO Elective	3.0		
Minor Elective	3.0	Minor Elective	4.0		
	15		**14**		**15**

Total Credits 185

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See degree requirements (p. 43).

COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

4 YR UG Co-op Concentration

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	CIVC 101	1.0	ENGL 103 or 113	3.0		
INFO 101	3.0	COOP 101*	1.0	INFO 103	3.0		
INFO 151	3.0	ENGL 102 or 112	3.0	INFO 153 or CS 172	3.0		
MATH 171	3.0	INFO 102	3.0	MATH 173	3.0		
UNIV CI101	1.0	INFO 152 or CS 171	3.0	UNIV CI101	1.0		
		MATH 172	3.0				
	15		**16**		**15**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 230 or 310	3.0	INFO 210	3.0	INFO 315	3.0	CT 140	3.0
CT 201	3.0	STAT 201	4.0	INFO 324	3.0	CT 250	3.0
INFO 150	3.0	Free Elective	3.0	INFO 371	3.0	INFO 310	3.0
INFO 200	3.0	INFO Elective	3.0	INFO 375	3.0	Liberal Studies Elective	3.0
INFO 215	3.0	Liberal Studies Elective	3.0	MATH 180	4.0	Minor Elective	4.0
	15		**16**		**16**		**16**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COOP EXPERIENCE		COOP EXPERIENCE		INFO 355	3.0	INFO 420	3.0
				Free Elective	6.0	Minor Electives	8.0
				Minor Elective	4.0	Science Sequence Course 2*	4.0
				Science Sequence Course 1*	4.0		
	0		**0**		**17**		**15**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0
INFO 405	3.0	Free Electives	4.0	Free Electives	12.0
INFO Electives	6.0	INFO Elective	3.0		
Minor Elective	3.0	Minor Elective	4.0		
	15		**14**		**15**

Total Credits 185

*
 See degree requirements (p. 43).
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

The following list is a sample of recent co-op job titles and employers:

- *Applications Architect,* Aetna
- *e-Communications Intern,* Airgas
- *PC Network Support,* Aramark
- *Information Systems Intern,* Campbell's Soup
- *Distributed WAN Support Co-op,* Cigna
- *Network Services,* GlaxoSmithKline
- *Programmer/Analyst*, Independence Blue Cross
- *Information Management Co-op,* Johnson & Johnson
- *Database Developer,* Princeton Plasma Physics
- *Website Developer,* QVC
- *Shared Services Co-op,* Wyeth

Career Opportunities

The demand for information systems professionals is strong. Graduates find careers in a number of areas, including designing information systems, leading project teams, planning, developing, and marketing information systems. Most information systems students enter the professional world right after graduation, but some continue their studies in advanced information technology programs.

Job titles of recent information systems graduates include:

- Security Analyst
- Network Systems Analyst
- Database Administrator
- Data Communications Analyst
- Systems Administrator
- Systems Engineer

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more detailed information on co-op and post-graduate opportunities.

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)
- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center

- Adjacent to future public square
- Access to Science Center’s nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries’ various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons’ Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's fully equipped conference room with 42” displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching” platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University’s network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory

- Over 556 TB of HDD-backed storage
- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College's research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the Information Systems degree is evaluated relative to the following Objectives and Outcomes.

BS in Information Systems Program Educational Objectives

Within three to five years of graduating, alumni of the program are expected to achieve one or more of the following milestones:

- Be valued contributors to private or public organizations as demonstrated by promotions, increased responsibility, or other professional recognition
- Contribute to professional knowledge as demonstrated by published papers, technical reports, patents, or conference presentations
- Succeed in continuing professional development as demonstrated by completion of graduate studies or professional certifications
- Demonstrate commitment and leadership within their profession and community as demonstrated by professional and community activity or contributions towards society's greater good and prosperity

BS in Information Systems Student Outcomes

The program enables students to attain by the time of graduation:

- An ability to apply knowledge of computing and mathematics appropriate to the discipline
- An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution
- An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs
- An ability to function effectively on teams to accomplish a common goal
- An understanding of professional, ethical, legal, security, and social issues
- An ability to communicate effectively with a range of audiences
- An ability to analyze the local and global impact of computing on individuals, organizations, and society
- Recognition of the need for and an ability to engage in continuing professional development
- An ability to use current techniques, skills, and tools necessary for computing practice
- An understanding of processes that support the delivery and management of information systems within a specific application environment

Software Engineering BSSE

Major: Software Engineering
Degree Awarded: Bachelor of Science in Software Engineering (BSSE)
Calendar Type: Quarter
Minimum Required Credits: 187.0
Co-op Options: Three Co-op (Five years); One Co-op (Four years)
Classification of Instructional Program (CIP) code: 14.0903
Standard Occupational Classification (SOC) code: *15-1132; 15-1133*

About the Program

The College of Computing & Informatics' Bachelor of Science in Software Engineering (BSSE) prepares students to design and build software systems. Software is essential to the functioning of modern society but high-quality software is very challenging to create. Software engineering focuses on the knowledge and skills to meet that challenge and create high quality software on schedule within budget.

The Software Engineering curriculum addresses a full range of software activities including gathering client requirements, designing and constructing software solutions, testing software, and modifying and extending existing systems. The curriculum also recognizes that most software is developed by teams, and students develop skills in project management and team operation. This hands-on curriculum combined with co-op provides real-world experience that culminates in a full-year software team capstone project (https://drexel.edu/cci/student-experience/senior-project/) involving in-depth study and application of computing and informatics. Graduates are well-prepared to function as software engineering team members and also move toward software engineering management.

The core courses address programming and use of software development tools, specification and design, software architecture, verification and validation, software evolution, and team projects. These courses are supplemented with courses drawn from computer science and Informatics that provide theoretical background and application knowledge. The full curriculum prepares BSSE students to apply processes, methods, and tools to the problem of building and maintaining software with a defined level of quality, at a predictable cost, on a predictable schedule.

Additional Information

For more information about this program, please visit the BS in Software Engineering webpage (https://drexel.edu/cci/academics/undergraduate-programs/bs-software-engineering/) on the College of Computing & Informatics website.

Degree Requirements

Software Engineering Requirements		
CS 164	Introduction to Computer Science	3.0
CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
CS 172	Computer Programming II	3.0
SE 181	Introduction to Software Engineering and Development	3.0
or SE 201	Introduction to Software Engineering and Development	
SE 210	Software Specification and Design I	3.0
SE 211	Software Specification and Design II	3.0
SE 310	Software Architecture I	3.0
SE 311	Software Architecture II	3.0
SE 320	Software Verification and Validation	3.0
SE 410	Software Evolution	3.0
Computer Science Requirements		
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 281	Systems Architecture	4.0
CS 283	Systems Programming	3.0
CS 472	Computer Networks: Theory, Applications and Programming	3.0
Information Systems Requirements		
INFO 210	Database Management Systems	3.0
INFO 310	Human-Centered Design Process & Methods	3.0
INFO 420	Software Project Management	3.0
Computing & Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Computing & Informatics Electives (see below)		**18.0**
Mathematics Requirements		
CS 270	Mathematical Foundations of Computer Science	3.0
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 123	Calculus III	4.0
MATH 221	Discrete Mathematics	3.0
STAT 201	Introduction to Business Statistics	4.0

STAT 202	Business Statistics II	4.0
Science Requirements		**18.0**
Select one of the following lab science sequences:		
BIO 131	Cells and Biomolecules	
& BIO 134	and Cells and Biomolecules Lab	
& BIO 132	and Genetics and Evolution	
& BIO 135	and Genetics and Evolution Lab	
& BIO 133	and Physiology and Ecology	
& BIO 136	and Anatomy and Ecology Lab	
CHEM 101	General Chemistry I	
& CHEM 102	and General Chemistry II	
& CHEM 103	and General Chemistry III	
PHYS 101	Fundamentals of Physics I	
& PHYS 102	and Fundamentals of Physics II	
& PHYS 201	and Fundamentals of Physics III	
Additional Science electives to reach 18.0 credits (see below)		
Arts & Humanities Requirements		
COM 230	Techniques of Speaking	3.0
COM 310 [WI]	Technical Communication	3.0
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
PHIL 105	Critical Reasoning	3.0
PHIL 311	Ethics and Information Technology	3.0
PSY 101	General Psychology I	3.0
PSY 330	Cognitive Psychology	3.0
Select two of the following:		8.0
ACCT 110	Accounting for Professionals	
ECON 201	Principles of Microeconomics	
ECON 202	Principles of Macroeconomics	
Arts & Humanities, Business, or Social Studies elective (see below)		3.0
University Requirements		
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development *	1.0
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
Free Electives		**12.0**
Total Credits		**187.0**

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Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Program Electives

Independent study courses and special topics courses must be approved by the department prior to enrollment to satisfy a program elective requirement.

- **Computing & Informatics electives**: any non-required CS, INFO, SE course numbered 300 or higher; a well as CT 210, CT 200, CT 320, CT 330
- **Science electives**: any CHEM (except CHEM 111, CHEM 112, CHEM 113, CHEM 114, CHEM 151), BIO (except BIO 161, BIO 162, BIO 163; can take only one of BIO 100, BIO 107; can take only one of BIO 101, BIO 109), PHYS (except PHYS 050, PHYS 100, PHYS 105, PHYS 151, PHYS 160, PHYS 305, PHYS 324, PHYS 405; cannot take both PHYS 131 and PHYS 181), ENVS, ENSS, PHEV.
- **Business electives**: any ACCT, BLAW, BUSN, ECON, ENTP, FIN, HRMT, INTB, MGMT, MIS, MKTG, OPM, OPR, ORGB, STAT, TAX
- **Social Studies electives**: any AFAS, ANTH, HIST, GST, JWST, PSCI, PSY, SOC, WGST
- **Arts & Humanities electives**: any ARCH, ARTH, CMGT, CJS, COM, CULA, DANC, EDEX, EDUC, ENGL (except ENGL 101,ENGL 102, ENGL 103, ENGL 105), ESTM, FASH, FMST, FMVD, GST, INTR, LING, MUSC, PHIL, PHTO, THTR, VSCM, VSST, WRIT, GMAP 260, ANIM 140, ANIM 141, ANIM 211, ANIM 212, and Foreign Language Courses from: ARBC, CHIN, FREN, GER, HBRW, ITAL, JAPN, KOR, SPAN

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

5 year, 3 coop (Spring/Summer Cycle)

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101 or 111	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171 or 175	3.0	MATH 123	4.0		
UNIV CI101	1.0	ENGL 102 or 112	3.0	UNIV CI101	1.0		
Arts/Humanities elective	3.0	MATH 122	4.0	Science Lab	4.0		
		Science Lab	4.0				
	16		**18**		**17**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 230	3.0	CS 260	4.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 265	3.0	INFO 210	3.0				
CS 270	3.0	MATH 221	3.0				
SE 181 or 201	3.0	SE 211	3.0				
SE 210	3.0	Science Elective	3.0				
	15		**16**		**0**		**0**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 310	3.0	CS 283	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
CS 281	4.0	SE 311	3.0				
PSY 101	3.0	STAT 202	4.0				
SE 310	3.0	Free Elective	2.0				
STAT 201	4.0	Science Elective	3.0				
	17		**15**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
INFO 420	3.0	INFO 310	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 105	3.0	PHIL 311	3.0				
SE 320	3.0	SE 410	3.0				
Computing & Informatics Elective	3.0	Computing & Informatics Elective	3.0				
Free Elective	3.0	Free Elective	3.0				
	15		**15**		**0**		**0**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
ACCT 110, ECON 201, or ECON 202	4.0	ACCT 110, ECON 201, or ECON 202	4.0	CI 493	3.0
CI 491	3.0	CI 492	3.0	Computing & Informatics Elective	3.0
CS 472	3.0	PSY 330	3.0	Science elective	4.0

Computing & Informatics Elective	3.0	Computing & Informatics Elective	6.0	Free Elective	3.5		
	13		**16**		**13.5**		

Total Credits 186.5

*

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

4 year, 1 coop (Spring/Summer Cycle)

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101 or 111	3.0	CS 171 or 175	3.0	ENGL 103 or 113	3.0		
MATH 121	4.0	ENGL 102 or 112	3.0	MATH 123	4.0		
UNIV CI101	1.0	MATH 122	4.0	UNIV CI101	1.0		
Arts/Humanities elective	3.0	Science Lab	4.0	Science Lab	4.0		
	16		**17**		**17**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
COM 230	3.0	COOP 101*	1.0	COM 310	3.0	CS 283	3.0
CS 265	3.0	CS 260	4.0	CS 281	4.0	SE 311	3.0
CS 270	3.0	INFO 210	3.0	PSY 101	3.0	STAT 202	4.0
SE 181 or 201	3.0	MATH 221	3.0	SE 310	3.0	Science Electives	7.0
SE 210	3.0	SE 211	3.0	STAT 201	4.0		
		Science Elective	3.0				
	15		**17**		**17**		**17**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
INFO 420	3.0	INFO 310	3.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 105	3.0	PHIL 311	3.0				
SE 320	3.0	SE 410	3.0				
Computing & Informatics Elective	3.0	Computing & Informatics Elective	3.0				
Free Elective	3.0	Free Elective	2.0				
	15		**14**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
ACCT 110, ECON 201, or ECON 202	4.0	ACCT 110, ECON 201, or ECON 202	4.0	CI 493	3.0
CI 491	3.0	CI 492	3.0	Computing & Informatics Elective	3.0
CS 472	3.0	PSY 330	3.0	Free Elective	6.5
Computing & Informatics Elective	3.0	Computing & Informatics Electives	6.0		
	13		**16**		**12.5**

Total Credits 186.5

*

Co-op cycles may vary. Students are assigned a co-op cycle (fall/winter, spring/summer, summer-only) based on their co-op program (4-year, 5-year) and major.
COOP 101 registration is determined by the co-op cycle assigned and may be scheduled in a different term. Select students may be eligible to take COOP 001 in place of COOP 101.

Co-op/Career Opportunities

Co-Op Options

Two co-op options are available for this program:

- five-year/three co-op
- four-year/one co-op

Career Opportunities

The demand for software engineering professionals is quite strong. Graduates can expect career opportunities in software design and development in a variety of application areas. Software engineering graduates are particularly well suited to work as members or leaders of software project teams; they have knowledge and skills to help them develop quality software within schedule and cost constraints.

According to the U.S. Bureau of Labor Statistics' Occupational Outlook Handbook (http://www.bls.gov/ooh/), software developer is among the fastest growing U.S. careers requiring at least a bachelor's degree, with an estimated 409,500 new jobs by 2030. Although they have jobs in most industries, many software developers work in computer systems design and related services firms or software publishers. The field's rapid growth is mainly due to the increase in demand for computer software, especially in healthcare.

Most software engineering students enter the professional world right after graduation, but some continue their studies in advanced software engineering programs.

Job titles of recent software engineering graduates include:

- Software Engineer
- Software Architect
- Software System Project Manager
- Software Project Team Leader

Visit the Drexel Steinbright Career Development Center (http://www.drexel.edu/scdc/) page for more detailed information on co-op and post-graduate opportunities.

3675 Market Street

The College of Computing & Informatics is located at 3675 Market (https://drexel.edu/cci/about/our-facilities/). Occupying three floors in the modern uCity Square building, CCI's home offers state-of-the-art technology in our classrooms, research labs, offices, meeting areas and collaboration spaces. 3675 Market offers Class A laboratory, office, coworking, and convening spaces. Located at the intersection of Market Street and 37th Street, 3675 Market acts as a physical nexus, bridging academic campuses and medical centers to the east and south, the commercial corridors along Market Street and Chestnut Street, and the residential communities to the north and west.

The uCity Square building offers:

- Speculative lab/office space
- World-class facilities operated by CIC (https://cic.us/philadelphia/)
- Café/restaurant on-site
- Quorum, a two-story, 15K SF convening space and conference center
- Adjacent to future public square
- Access to Science Center’s nationally renowned business acceleration and technology commercialization programs

Drexel University Libraries

The Drexel University Libraries (https://www.library.drexel.edu/) is a one-stop resource for all members of the Drexel community, providing access to millions of print and online books, journals, databases and other media, as well as hundreds of online course and research guides (https://libguides.library.drexel.edu/libraryguides/), workshops (https://www.library.drexel.edu/news-and-events/events/), and tutorials (https://libguides.library.drexel.edu/tutorials/). Expert librarians offer a variety of consultation services (https://www.library.drexel.edu/research-support/librarians-subject/) virtually or in person, including help with course-related projects, strategies for finding and evaluating authoritative information, and approaches to utilizing, organizing, and presenting scholarship.

Students in the College of Computing & Informatics also have access to the W. W. Hagerty Library (https://www.library.drexel.edu/about/locations/) where they can take advantage of the Libraries’ various learning environments (https://www.library.drexel.edu/services/reserve-room/), including group study rooms, collaborative and silent study areas, and 24/7 study space in the Dragons’ Learning Den. The Libraries also offers a wellness room (https://www.library.drexel.edu/news-and-events/programs-and-initiatives/Wellness-Room/), printing and scanning services (https://www.library.drexel.edu/services/printing-scanning-computing/), and laptops, portable power chargers, (https://www.library.drexel.edu/services/printing-scanning-computing/equipment-loan/) and other equipment you can borrow for use in the Library.

CCI Commons

Located on the 10th floor of 3675 Market Street, the CCI Commons is an open lab and collaborative work environment for students. It features desktop computers, a wireless/laptop area, free black and white printing, and more collaborative space for its students. Students have access to 3675 Market's

fully equipped conference room with 42” displays and videoconferencing capabilities. The CCI Commons provides technical support to students, faculty, and professional staff. In addition, the staff provides audio-visual support for all presentation classrooms within 3675 Market. Use of the CCI Commons is reserved for all students taking CCI courses.

The computers for general use are Microsoft Windows and Macintosh OSX machines with appropriate applications which include the Microsoft Office suite, various database management systems, modeling tools, and statistical analysis software. Library-related resources may be accessed at the CCI Commons and through the W.W. Hagerty Library. The College is a member of the "Azure Dev Tools for Teaching” platform that allows students free access to a wide array of Microsoft software titles and operating systems.

The CCI Commons, student labs, and classrooms have access to networked databases, print and file resources within the College, and the Internet via the University’s network. Email accounts, Internet and BannerWeb access are available through the Office of Information Resources and Technology.

Computer Support for Teaching

The CCI server room houses a multitude of servers to support faculty research, staff operations, and student learning. Services provided include a Linux compute cluster which is open to all faculty, staff, and students, multiple virtualization environments to meet different needs of faculty, staff, and students, and other single-purpose servers to support various operations throughout the college. The compute cluster provides a common environment for students to develop software, which makes testing easier for the TAs and faculty. Our virtualization environments allow college members the flexibility of a cloud environment with local support and direct cost recovery options. For those who need dedicated hardware, we also support dedicated research systems.

Classrooms are outfitted with laser projectors, 4K displays, class capture hardware, and the Wolfvision Cynap. The Cynap controls the AV distribution throughout the room and can display up to 4 streams simultaneously. These include the local PC, a laptop connected directly to the podium, or up to 4 streaming devices. Windows, macOS, iOS and Android devices can all connect wirelessly to the presentation system, allowing collaboration and freedom to roam the classroom for better interactivity. Wireless networking and outlets are also available for students throughout the classrooms. Laptops are available for checkout from the CCI Commons desk.

Additionally, CCI is hosting and supporting multiple Virtual Computing Lab environments for students to use that mimics the physical computer labs in CCI. This technology allows both online and face to face students to have the same experience when using computing facilities.

CCI Virtual Environments

CCI hosts a variety of virtual environments, which support all levels of research, academics, and administration at CCI. These include OpenStack, Proxmox VE, VMWare, and Xen architectures, backed by storage in CEPH. Multiple environments allow CCI IT to provide researchers with the level of control appropriate for the project at hand and make efficient use of project funding. External cloud vendors such as AWS and Google Cloud Platform are also used when appropriate.

CCI continues to invest in these virtual environments, and explores emerging environments, to continue to best support CCI research and teaching. CPU cores, storage, and memory are added at every opportunity to these flexible, scalable environments. The current capacity of the system includes:

- 1760 CPU Cores
- 6 TB of Memory
- Over 556 TB of HDD-backed storage
- 122 TB of high-performance SSD-backed storage
- 12 GPUs with room for expansion through funded research for high-performance computing needs

CCI Learning Center

The CCI Learning Center (CLC), located in 3675 Market Street's CCI Commons student computer lab, provides consulting and other learning resources for students taking courses offered by the Computer Science Department. The CLC is staffed by graduate and undergraduate computer science students from the College of Computing & Informatics.

The CLC and CCI Commons serve as a central hub for small group work, student meetings, and TA assistance.

Research Laboratories

The College houses multiple research labs, led by CCI faculty, in 3675 Market Street including: the Metadata Research Center (MRC), Interactive Systems for Healthcare (IS4H) Research, Economics and Computation (EconCS), The TeX-Base Lab, SPiking And Recurrent SoftwarE (SPARSE) Coding, Human-System Evaluation and Analysis Lab (H-SEAL), Applied Symbolic Computation Laboratory (ASYM), Security and Privacy Analytics Lab (SePAL), Software Engineering and Analytics Research (SOAR), Software Engineering Research Group (SERG), Social Computing Research Group, Vision and Cognition Laboratory (VisCog). For more information on these laboratories, please visit the College’s research web page (https://drexel.edu/cci/research/overview/).

Program Level Outcomes

The College of Computing & Informatics works continually to improve its degree programs. As part of this effort, the software engineering degree is evaluated relative to the following Objectives and Outcomes.

Program Educational Objectives

Within three to five years of graduating, alumni of the program are expected to achieve one or more of the following milestones:

- Graduates of the program obtain employment as software developers where their software and communication skills eventually propel them toward technical and administrative leadership positions in industry and government.
- Graduates of the program demonstrate an ability to continue to learn throughout their career and to keep pace with changing technology as appropriate to their positions.
- Graduates of the program specialize and enhance their software engineering knowledge by enrolling and completing technical graduate courses and other technical education to position them to advance software engineering practice as senior technical staff members or managers.
- Graduates of the program specialize and enhance their software engineering knowledge by enrolling and graduating from MSc and PhD degree programs to position them to contribute to the intellectual foundations of the discipline of software engineering as researchers in industrial and government laboratories as well as in academia.
- Graduates of the program advance toward becoming leaders in disciplines other than software engineering by enrolling and graduating from graduate-level degree programs in complimentary disciplines such as law and business where the BSSE serves as an educational foundation.
- Graduates of the program will demonstrate an awareness of their professional and social responsibility as software engineers by participation in professional activities and application of their knowledge for the good of society.

Software Engineering Student Outcomes

The program enables students to attain by the time of graduation:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Computer and Informatics Undeclared

About the Program

The Computer & Informatics Undeclared program allows students to explore academic options within the College of Computing & Informatics (https://drexel.edu/cci/) before declaring a major and while staying on track during their first year.

The Computer & Informatics Undeclared program (https://drexel.edu/cci/academics/undergraduate-programs/undecided-major/) is not a major; however, all the courses in the first year are required in some form in the various majors in the College of Computing & Informatics. This selection of courses will “follow” the student to an eventual chosen major in the college. With the help of an advisor, students can select courses based on their interests and goals. No later than the end of spring term in the first academic year, students are required to select an appropriate major (Computer Science, Computing and Security Technology, Data Science, Information Systems, Software Engineering) which will lead to a bachelor's degree.

Students will complete co-ops in accordance with the requirements for the major that they choose.

Admission Requirements

There are no specific requirements for admission into the undeclared option beyond those that are required for any student applying to majors in the College of Computing & Informatics at Drexel University.

Program Requirements

University Requirements		
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
MATH courses according to placement		12.0
UNIV CI101	The Drexel Experience	2.0
COOP 101	Career Management and Professional Development	1.0
CIVC 101	Introduction to Civic Engagement	1.0
College Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
Based on area of interest select appropriate options in consultation with an advisor		
CS/INFO Programming courses		9.0
Exploration of major options		9.0
Major Credits		**86.0**
Electives		**51.5**
Total Credits		**186.5**

Sample Plan of Study

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
ENGL 101 or 111	3.0	ENGL 102 or 112	3.0	ENGL 103 or 113	3.0		
UNIV CI101	1.0	CIVC 101	1.0	UNIV CI101	1.0		
MATH*	4.0	COOP 101	1.0	MATH*	4.0		
Programming**	3.0	MATH*	4.0	Programming**	3.0		
Major credits***	3.0	Programming**	3.0	Major credits***	3.0		
		Major credits***	3.0				
	16		**17**		**16**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
Major credits	9.0	Major credits	9.0	Major credits	9.0	VACATION	
Electives	6.0	Electives	6.0	Electives	6.0		
	15		**15**		**15**		**0**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
Major credits	9.0	Major credits	9.0	Major credits	10.0	VACATION	
Electives	6.0	Electives	6.0	Electives	5.0		
	15		**15**		**15**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits
Major credits	10.0	Major credits	10.0	Major credits	10.0
Electives	6.0	Electives	6.0	Electives	5.5
	16		**16**		**15.5**

Total Credits 186.5

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MATH courses according to placement

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Programming courses according to area of interest

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Major credits according to area of interest

Computer Science BS / Computer Science MS

Major: Computer Science
Degree Awarded: Bachelor of Science (BS) and Master of Science (MS)
Calendar Type: Quarter
Minimum Required Credits: 225.5
Co-op Options: One Co-op (Five years)
Classification of Instructional Programs (CIP) code: *11.0701*
Standard Occupational Classification (SOC) code: 11-3021

About the Program

The College of Computing & Informatics (https://drexel.edu/cci/) offers an accelerated degree program designed to allow students to complete both a bachelor's degree and a graduate degree along with cooperative educational experience in fewer years than would be typical if pursuing the degrees separately.

Admission Requirements

The guidelines for applying to the Computer Science BS/MS Accelerated Degree program are as follows:

- University regulations require application after the completion of 90.0 credits but before the completion of 120.0 credits.
- Applicants must have an overall cumulative Grade Point Average of 3.5 or higher.
- Letters of recommendation from two Computer Science faculty are required.
- Students must submit a plan of study. Consult your advisor and course schedules for guidance.
- Applicants must have completed the following courses with a minimum GPA of 3.50

Degree Requirements

The courses below should be taken at Drexel. Seek guidance from your advisor regarding additional coursework if any courses below have been taken outside of Drexel.

CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
CS 172	Computer Programming II	3.0
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
CS 281	Systems Architecture	4.0
MATH 221	Discrete Mathematics	3.0

Requirements

The requirements of the Computer Science BS/MS program follow the requirements of both the BS in Computer Science (http://catalog.drexel.edu/undergraduate/collegeofcomputingandinformatics/computerscience/#requirementsbstext) and the MS in Computer Science (http://catalog.drexel.edu/graduate/collegeofcomputingandinformatics/computerscience/#degreerequirementsmstext). Students must complete all the requirements of the BS in Computer Science (http://catalog.drexel.edu/undergraduate/collegeofcomputingandinformatics/computerscience/#requirementsbstext) except that they may replace 6.0 credits of free electives (still maintaining the 180.0 credit minimum for the BS degree) with graduate coursework. In addition, students must complete 45.0 credits of graduate courses to satisfy the requirements of the MS in Computer Science (http://catalog.drexel.edu/graduate/collegeofcomputingandinformatics/computerscience/#degreerequirementsmstext). Please refer to the linked program pages for the details of these requirements.

Undergraduate Degree Requirements		
Computer Science Requirements		
CS 164	Introduction to Computer Science	3.0
CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
CS 172	Computer Programming II	3.0
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
CS 270	Mathematical Foundations of Computer Science	3.0
CS 277	Algorithms and Analysis	3.0
CS 281	Systems Architecture	4.0
CS 283	Systems Programming	3.0
CS 360	Programming Language Concepts	3.0
SE 181	Introduction to Software Engineering and Development	3.0

or SE 201	Introduction to Software Engineering and Development	
SE 310	Software Architecture I	3.0
Computer Science concentration courses (see below)		**18.0**
Computer Science electives (see below)		**6.0**
Computing & Informatics Requirements		
CI 101	Computing and Informatics Design I	2.0
CI 102	Computing and Informatics Design II	2.0
CI 103	Computing and Informatics Design III	2.0
CI 491 [WI]	Senior Project I	3.0
CI 492 [WI]	Senior Project II	3.0
CI 493 [WI]	Senior Project III	3.0
Mathematics Requirements		
MATH 121	Calculus I	4.0
MATH 122	Calculus II	4.0
MATH 123	Calculus III	4.0
MATH 200	Multivariate Calculus	4.0
MATH 201	Linear Algebra	4.0
MATH 221	Discrete Mathematics	3.0
MATH 311	Probability and Statistics I	4.0
Science Requirements		**19.0**
Select one of the following lab science sequences:		
BIO 131 & BIO 134 & BIO 132 & BIO 135 & BIO 133 & BIO 136	Cells and Biomolecules and Cells and Biomolecules Lab and Genetics and Evolution and Genetics and Evolution Lab and Physiology and Ecology and Anatomy and Ecology Lab	
CHEM 101 & CHEM 102 & CHEM 103	General Chemistry I and General Chemistry II and General Chemistry III	
PHYS 101 & PHYS 102 & PHYS 201	Fundamentals of Physics I and Fundamentals of Physics II and Fundamentals of Physics III	
Science electives (see below)		
Arts & Humanities Requirements		
COM 230	Techniques of Speaking	3.0
ENGL 101	Composition and Rhetoric I: Inquiry and Exploratory Research	3.0
or ENGL 111	English Composition I	
ENGL 102	Composition and Rhetoric II: Advanced Research and Evidence-Based Writing	3.0
or ENGL 112	English Composition II	
ENGL 103	Composition and Rhetoric III: Themes and Genres	3.0
or ENGL 113	English Composition III	
PHIL 311	Ethics and Information Technology	3.0
Writing & Communications electives (see below)		**6.0**
Arts & Humanities, Business, or Social Studies electives (see below) *		**18.0**
Universtiy Requirements		
CIVC 101	Introduction to Civic Engagement	1.0
COOP 101	Career Management and Professional Development	1.0
UNIV CI101	The Drexel Experience	2.0
or CI 120	CCI Transfer Student Seminar	
Free electives		**15.0**
Graduate Degree Requirements		
Core Courses		**15.0**
Choose 1 course from each category		
Theory		
CS 521	Data Structures and Algorithms I	
CS 525	Theory of Computation	
Computer Systems		
CS 543	Operating Systems	
CS 544	Computer Networks	
Intelligent Systems		
CS 510	Introduction to Artificial Intelligence	
CS 613	Machine Learning	

Programming Systems		
CS 550	Programming Languages	
SE 575	Software Design	
Applications		
CS 500	Fundamentals of Databases	
CS 523	Cryptography	
CS 530	Developing User Interfaces	
CS 536	Computer Graphics	
CS 540	High Performance Computing	
CS 558	Game Engine Programming	
CS 567	Applied Symbolic Computation	
CS 583	Introduction to Computer Vision	
CS 590	Privacy	
SE 578	Security Engineering	
Major Specifc Electives		**18.0**
Choose 6 additional graduate-level CS and/or SE courses except CS 501, CS 502, CS 503, CS 504		
May include 6 credits of thesis coursework		
Flexible Electives		**12.0**
Choose 4 additional courses, which may include:		
Any graduate-level courses within the College (CI, CS, CT, DSCI, INFO, SE)		
Up to 6 credits of independent study		
Up to 6 credits of thesis coursework		
Up to 6 credits of related graduate-level coursework outside of the College, with priod approval by the College		
Total Credits		**226.0**

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At least 3.0 credits must be taken from a Business category course (see below) and at least 3.0 credits must be taken from a Social Studies category (see below)

When completing undergraduate CS electives and graduate CS courses, students should take care to avoid equivalent courses at both the undergraduate and graduate levels. Please consult with your advisor for courses that should not be taken at both the undergraduate and graduate level.

Program Electives

Independent Study courses and Special Topics courses must be approved by the department prior to enrollment to satisfy a program elective requirement.

- **Computer Science electives**: any undergraduate CS or SE course (300-499) or any of the following courses: DSCI 351 , DSCI 471, INFO 310, INFO 323 ECE 302, ECEC 412, ECEC 413, GMAP 377, GMAP 378, MATH 300, MATH 301, MATH 305, MATH 475.
- **Science electives**: any CHEM (100-499 [except CHEM 111, CHEM 112, CHEM 113, CHEM 114, CHEM 151]), BIO (100-499 [except BIO 161, BIO 162, BIO 163; can take only one of BIO 100 or BIO 107; can take only one of BIO 101 or BIO 109]), PHYS (100-499 [except PHYS 050, PHYS 100, PHYS 151, PHYS 160, PHYS 305, PHYS 324, PHYS 405; cannot take both PHYS 131 & PHYS 181]), ENVS (100-499), ENSS (100-499), PHEV (100-499)
- **Writing & Communications electives**: any undergraduate WRIT (100-499), COM (100-499), ENGL (100-499) courses officially certified as Writing Intensive (WI), SCRP 270 [WI] , and SCRP 275 [WI]
- **Business electives**: any undergraduate ACCT (100-499), BLAW (100-499), BUSN (100-499), ECON (100-499), ENTP (100-499), FIN (100-499), HRMT (100-499), INTB (100-499), MGMT (100-499), MIS (100-499), MKTG (100-499), OPM (100-499), OPR (100-499), ORGB (100-499), STAT (100-499), TAX (100-499)
- **Social Studies electives**: any AFAS (100-499), ANTH (100-499), GST (100-499), HIST (100-499), JWST (100-499), PSCI (100-499), PSY (100-499), SOC (100-499), WGST (100-499)
- **Arts & Humanities electives**: any undergraduate ARCH (100-499), ARTH (100-499), CMGT (100-499), CJS (100-499), COM (100-499), CULA (100-499), DANC (100-499), EDEX (100-499), EDUC (100-499), ENGL (100-499 [except ENGL 101, ENGL 102, ENGL 103, ENGL 105, ENGL 111, ENGL 112, ENGL 113]), ESTM (100-499), FASH (100-499), FMST (100-499), FMTV (100-499), GST (100-499), INTR (100-499), LING (100-499), MUSC (100-499), PHIL (100-499), PHTO (100-499), THTR (100-499), VSCM (100-499), VSST (100-499), WRIT (100-499). Foreign Language (any undergraduate course 101-499 in ARBC, CHIN, FREN, GER, HBRW, ITAL, JAPN, KOR, SPAN, including independent studies and special topics), and GMAP 260, ANIM 140, ANIM 141, ANIM 211, ANIM 212

Computer Science Concentrations

Students must complete two of the following Computer Science concentrations for a total of 18.0 credits. The concentrations may overlap by one course. Students should check with the College for any additional Special Topics courses being offered that may be appropriate for one of the concentrations. The student may propose a custom-designed concentration with departmental approval; courses proposed must be of level 300 and above.

The selected concentrations require 3 courses with a minimum of 9.0 credits and at least one Core Course

Algorithms and Theory	
CS 300	Applied Symbolic Computation
CS 303	Algorithmic Number Theory and Cryptography
CS 440	Theory of Computation *
CS 441	Compiler Implementation
CS 457	Data Structures and Algorithms I *
CS 458	Data Structures and Algorithms II
MATH 300	Numerical Analysis I
MATH 301	Numerical Analysis II
MATH 305	Introduction to Optimization Theory
MATH 475	Cryptography
Computer Systems & Architecture	
CS 314	Computing in the Small
CS 352	Processor Architecture & Analysis
CS 361	Concurrent Programming
CS 370	Operating Systems *
CS 429	Software Defined Radio Laboratory
CS 441	Compiler Implementation
CS 461	Database Systems *
CS 472	Computer Networks: Theory, Applications and Programming *
CS 475	Network Security
CS 476	High Performance Computing
CS 479	Advanced Network Security
INFO 323	Cloud Computing and Big Data
ECE 302	Design with Embedded Processors
ECEC 412	Modern Processor Design
ECEC 413	Introduction to Parallel Computer Architecture
ECEC 414	High Performance Computing
Programming Languages and Systems	
CS 361	Concurrent Programming *
CS 370	Operating Systems
CS 377	Software Security
CS 429	Software Defined Radio Laboratory
CS 440	Theory of Computation *
CS 441	Compiler Implementation
CS 461	Database Systems
ECEC 413	Introduction to Parallel Computer Architecture
Computer Graphics, Vision, and Interaction	
CS 314	Computing in the Small
CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development
CS 375	Web Development *
CS 387	Game AI Development
CS 430	Computer Graphics
CS 431	Advanced Rendering Techniques
CS 432	Interactive Computer Graphics *
CS 435	Computational Photography
CS 438	Game Engine Programming
CS 478	Advanced Web Development
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II
INFO 310	Human-Centered Design Process & Methods
Artificial Intelligence and Machine Learning	
CS 380	Artificial Intelligence *
CS 383	Machine Learning
CS 385	Evolutionary Computing
CS 387	Game AI Development
CS 455	Computational Network Neuroscience
CS 481	Advanced Artificial Intelligence
CS 482	Robust Machine Learning

CS 486	Topics in Artificial Intelligence
DSCI 351	Recommender Systems
DSCI 471	Applied Deep Learning
Computer Security and Privacy	
CS 300	Applied Symbolic Computation
CS 303	Algorithmic Number Theory and Cryptography
CS 377	Software Security *
CS 465	Privacy and Trust
CS 475	Network Security *
CS 479	Advanced Network Security
MATH 475	Cryptography
Software Engineering	
CS 375	Web Development
CS 478	Advanced Web Development
INFO 420	Software Project Management
SE 311	Software Architecture II *
SE 320	Software Verification and Validation *
SE 410	Software Evolution
SE 420	Open Source Software Engineering
Game Programming and Development	
CS 341	Serious Game Development
CS 342	Experimental Game Development
CS 345	Computer Game Design and Development *
CS 387	Game AI Development
CS 438	Game Engine Programming
GMAP 377	Game Development: Workshop I
GMAP 378	Game Development: Workshop II

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Core Course

Writing-Intensive Course Requirements

In order to graduate, all students must pass three writing-intensive courses after their freshman year. Two writing-intensive courses must be in a student's major. The third can be in any discipline. Students are advised to take one writing-intensive class each year, beginning with the sophomore year, and to avoid “clustering” these courses near the end of their matriculation. Transfer students need to meet with an academic advisor to review the number of writing-intensive courses required to graduate.

A "WI" next to a course in this catalog may indicate that this course can fulfill a writing-intensive requirement. For the most up-to-date list of writing-intensive courses being offered, students should check the Writing Intensive Course List (https://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/faculty-programs/#writing-intensive-list) at the University Writing Program (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/). (http://drexel.edu/coas/academics/departments-centers/english-philosophy/university-writing-program/drexel-writing-center/) Students scheduling their courses can also conduct a search for courses with the attribute "WI" to bring up a list of all writing-intensive courses available that term.

Sample Plan of Study

First Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 101	2.0	CI 102	2.0	CI 103	2.0	VACATION	
CS 164	3.0	CIVC 101	1.0	CS 172	3.0		
ENGL 101 or 111	3.0	COOP 101*	1.0	ENGL 103 or 113	3.0		
MATH 121	4.0	CS 171 or 175	3.0	MATH 123	4.0		
UNIV CI101	1.0	ENGL 102 or 112	3.0	UNIV CI101	1.0		
(UG) Arts & Humanities Elective	4.0	MATH 122	4.0	(UG) Lab Science course	4.5		
		(UG) Lab Science course	4.5				
	17		**18.5**		**17.5**		**0**

Second Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CS 265	3.0	CS 260	4.0	CS 277	3.0	CS 283	3.0
CS 270	3.0	MATH 200	4.0	CS 281	4.0	CS 360	3.0

MATH 201	4.0	MATH 221	3.0	COM 230	3.0	(UG) Arts & Humanities electives	5.0
SE 181 or 201	3.0	(UG) Science elective	4.0	SE 310	3.0	(UG) Writing & Communications elective	3.0
(UG) Science elective	4.0	(UG) Writing & Communications elective	3.0	(UG) Science elective	3.0		
	17		**18**		**16**		**14**

Third Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
MATH 311	4.0	(UG) Arts & Humanities elective	4.0	COOP EXPERIENCE		COOP EXPERIENCE	
PHIL 311	3.0	(UG) Computer Science electives / concentration	12.0				
(UG) Computer Science electives / concentration	9.0						
	16		**16**		**0**		**0**

Fourth Year

Fall	Credits	Winter	Credits	Spring	Credits	Summer	Credits
CI 491	3.0	CI 492	3.0	CI 493	3.0	STUDENT CLASSIFIED AS GRADUATE STUDENT	
(UG) Business elective	4.0	(UG) Free electives	6.0	(UG) Free elective	3.0	(GR) MS Core courses	6.0
(UG) Science elective	3.0	(GR) MS Core Course counts as (UG) Free Elective	3.0	(UG) Computer Science electives / concentration	3.0	(GR) MS Major Specific elective	3.0
(GR) MS Core Course counts as (UG) Free Elective	3.0			(UG) Arts & Humanities elective	3.0		
				Student awarded BS Degree			
	13		**12**		**12**		**9**

Fifth Year

Fall	Credits	Winter	Credits	Spring	Credits
(GR) MS Major Specific electives	9.0	(GR) MS Core course	3.0	(GR) MS Major Specific elective	3.0
(GR) MS Flexible Elective	3.0	(GR) MS Major Specific elective	3.0	(GR) MS Flexible electives	6.0
		(GR) MS Flexible elective	3.0		
	12		**9**		**9**

Total Credits 226

Minor in Artificial Intelligence and Learning

About the Minor

This minor explores the foundation and application of artificial intelligence and machine learning. It is designed to be an advanced minor with a focus on deep understanding of the underlying mathematics and algorithms used in AI. This minor will utilize aspects of computer science, engineering, mathematics, and data science.

All pre-requisites of all classes need to be fulfilled. Courses in this minor require various 100- and 200-level courses as pre-requisites, which do not count toward the 24 credits of the minor itself. This requires 6 earlier 3-credit courses to satisfy pre-requisites of the two required courses. Some elective choices may have additional requirements. A grade of C or better must be earned for each course in this minor for it to be counted.

Admission Requirements

The Artificial Intelligence and Learning minor is available to all University students in good standing.

Program Requirements

Required Courses		
CS 380	Artificial Intelligence	3.0
CS 383	Machine Learning	3.0
Elective Courses		**18.0**
At least 3 elective courses must be from the computer science department (CS, DSCI, INFO).		
BMES 421	Biomedical Imaging Systems I: Images	
BMES 477	Neuroengineering I: Neural Signals	
CS 385	Evolutionary Computing	
CS 387	Game AI Development	
CS 435	Computational Photography	
CS 455	Computational Network Neuroscience	
CS 481	Advanced Artificial Intelligence	
CS 482	Robust Machine Learning	
CS 486	Topics in Artificial Intelligence	
CS I499	Independent Study in Computer Science *	
DSCI 351	Recommender Systems	
DSCI 471	Applied Deep Learning	
ENGR 361	Statistical Analysis of Engineering Systems	
ECE 310	Machine Learning Engineering Practicum	
ECE 361	Probability and Data Analytics for Engineers	
ECEC 487	Pattern Recognition	
ECES 434	Applied Digital Signal Processing	
ECES 441	Bioinformatics	
INFO 300	Information Retrieval Systems	
INFO 332	Exploratory Data Analytics	
INFO 371	Data Mining Applications	
INFO 432	Advanced Data Analytics	
INFO 440	Social Media Data Analysis	
INFO I499	Independent Study in INFO *	
MATH 305	Introduction to Optimization Theory	
Total Credits		**24.0**

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Departmental permission needed. Independent Study topic must be related to Artificial Intelligence.

Restrictions: CS and SE students may not count more than 9.0 credits of their required CCI electives towards this minor. CS students pursuing this minor may not pursue the Artificial Intelligence and Machine Learning concentration in the CS degree.

Additional Information

For more information, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

Minor in Computer Science

About the Minor

The Computer Science minor provides students with a breadth of knowledge in areas that form the foundation of computer science. The student adds some depth by selecting courses from a list of advanced computer science courses.

The Computer Science minor is available to all University students in good standing, with the exception of Computer Science majors.

Prerequisites

One of the following Mathematics sequences must be completed before entering the program:

- MATH 101 and MATH 102
- MATH 121 and MATH 122

Program Requirements

CS 171	Computer Programming I	3.0
or CS 175	Advanced Computer Programming I	
or ENGR 131	Introductory Programming for Engineers	
or ENGR 132	Programming for Engineers	
CS 172	Computer Programming II	3.0
or ECE 105	Programming for Engineers II	
CS 260	Data Structures	4.0
CS 265	Advanced Programming Tools and Techniques	3.0
Additional CS courses numbered 200 or higher. *		12.0
Total Credits		**25.0**

*

Restrictions: For Software Engineering BS majors, allowable additional CS courses include CS 277 and CS courses numbered 300 or higher (excluding CS 472).

Additional Information

For more information about this program, please visit the College of Computing & Informatics (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/)website.

Minor in Computing Technology

About the Minor

The demand for individuals with technology skills is increasing and essential in today's internet-dominated society. Almost every field nowadays relies on technology. People in all fields may become responsible for building or using computer networks and increasingly more complex websites, cloud computing environments, and intranets. The minor in Computing Technology combines basic courses in computing technology required to help organizations build infrastructure solutions.

Any student in any major can benefit from a minor in Computing Technology. Graduates with such background knowledge are prepared to actively participate in the application of technology within the major area of study.

The minor is available to all University students in good standing with the exception of students majoring in Computing and Security Technology.

Program Requirements

CS 171	Computer Programming I	3.0
or INFO 151	Web Systems and Services I	
CT 140	Network Administration I	3.0
CT 200	Server I	3.0
CT 201	Information Technology Security I	3.0
CT 210	Open Server I	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 210	Database Management Systems	3.0
Computer Technology Elective, select 1 of the following		3.0
CT 310	Open Server II	
CT 320	Server II	

CT 330	Network Administration II	
INFO 365	Database Administration I	
Total Credits		**24.0**

Additional Information

For more information, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

Minor in Data Science

About the Minor

Data science provides a foundation for problem-solving in a data-driven society. The minor in Data Science combines basic courses in statistics, information and technology, and social contexts to address problems that require large and disparate datasets.

Any student in any major can benefit from a minor in data science. Graduates with such background knowledge are prepared to actively participate in the application of data science within their major area of study.

The minor is available to all University students in good standing with the exception of students majoring in Data Science.

Program Requirements

CS 171	Computer Programming I	3.0
CS 172	Computer Programming II	3.0
INFO 103	Introduction to Data Science	3.0
INFO 212	Data Science Programming I	3.0
STAT 201	Introduction to Business Statistics	4.0
STAT 202	Business Statistics II	4.0
Select 2 of the following:		6.0-7.0
CS 260	Data Structures	
CS 265	Advanced Programming Tools and Techniques	
CS 270	Mathematical Foundations of Computer Science	
CS 380	Artificial Intelligence	
CS 383	Machine Learning	
CS 461	Database Systems	
or INFO 210	Database Management Systems	
DSCI 351	Recommender Systems	
DSCI 471	Applied Deep Learning	
INFO 202	Data Curation	
INFO 213	Data Science Programming II	
INFO 250	Information Visualization	
INFO 323	Cloud Computing and Big Data	
INFO 332	Exploratory Data Analytics	
INFO 432	Advanced Data Analytics	
INFO 440	Social Media Data Analysis	
Total Credits		**26.0-27.0**

Additional Information

For more information about this program, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

Minor in Human Computer Interaction

About the Minor

The minor in Human Computer Interaction provides a course of study for students who would like to improve the integration of computing in the lives of individuals and to use computing to enable collaboration within groups. The minor combines courses in human computer interaction, ubiquitous computing, graphical interface design, and social computing.

The minor is available to all University students in good standing with the exception of students already majoring in Information Systems, Computing and Security Technology, or Data Science.

Program Requirements

CS 171	Computer Programming I	3.0
or INFO 151	Web Systems and Services I	
INFO 102	Introduction to Information Systems	3.0
INFO 215	Social Aspects of Information Systems	3.0
INFO 310	Human-Centered Design Process & Methods	3.0
INFO 405	Social and Collaborative Computing	3.0
HCI Electives **		
Select 3 of the following:		9.0
CS 341	Serious Game Development	
CS 342	Experimental Game Development	
CS 345	Computer Game Design and Development	
CS 375	Web Development	
CS 380	Artificial Intelligence	
INFO 101	Introduction to Computing and Security Technology	
INFO 103	Introduction to Data Science	
INFO 110	Introduction to Human-Computer Interaction	
INFO 150	Introduction to Ubiquitous Computing	
INFO 250	Information Visualization	
INFO 405	Social and Collaborative Computing	
INFO 440	Social Media Data Analysis	
Total Credits		**24.0**

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CCI majors: Replace INFO 110 with an additional HCI elective.

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HCI Elective Recommendations:
For non-CCI majors: INFO 101 INFO 103 INFO 150 INFO 250
For CS majors: CS 341 CS 342 CS 345 CS 380 CS 375

* An additional 9.0 credits or more are to be chosen from other course offerings in HCI pertinent to the student's overall program of study. Guidance in selecting these electives will be provided by staff and faculty of the College of Computing & Informatics.

Additional Information

For more information, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

Minor in Information Systems

About the Minor

Drexel's undergraduate Information Systems minor combines basic courses in areas including human-computer interaction, systems analysis, database management systems, and computer networking technology. The Information Systems minor is available to all University students in good standing with the exception of students already majoring in Computing and Security Technology or Data Science.

Program Requirements

Required Courses		
CT 140	Network Administration I	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
INFO 102	Introduction to Information Systems	3.0
INFO 103	Introduction to Data Science	3.0
INFO 200	Systems Analysis I	3.0
INFO 210	Database Management Systems	3.0
INFO 310	Human-Centered Design Process & Methods	3.0
One information system elective *		3.0
Total Credits		**24.0**

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An additional 3 credits or more are to be chosen from other course offerings in information systems pertinent to the student's overall program of study. Guidance in selecting these electives will be provided by staff and faculty of the College of Computing and Informatics.

Additional Information

For more information, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

Minor in Security Technology

About the Minor

The demand for individuals with security related skills is increasing and essential in today's internet-dominated society. Computer and information systems managers are becoming more involved with the security of data, responsible for sophisticated and more efficient computer networks, and increasingly more complex websites and intranets. The minor in Security Technology combines basic courses in security and technology required to help organizations keep their computer systems secure.

Any student in any major can benefit from a minor in Security Technology. Graduates with such background knowledge are prepared to actively participate in the application of security technology within the major area of study.

The minor is available to all University students in good standing with the exception of students majoring in Computing and Security Technology.

Program Requirements

CT 140	Network Administration I	3.0
CT 201	Information Technology Security I	3.0
CT 210	Open Server I	3.0
CT 301	Information Technology Security II	3.0
CT 312	Access Control and Intrusion Detection Technology	3.0
CT 412	Information Technology Security Policies	3.0
INFO 101	Introduction to Computing and Security Technology	3.0
Security Technology Elective, Select 1 of the following:		3.0
CT 362	Network Auditing Tools	
CT 393	Information Technology Security Risk Assessment	
CT 415	Disaster Recovery and Continuity Planning	
Total Credits		**24.0**

Additional Information

For more information, please visit the College of Computing & Informatics website (https://drexel.edu/cci/academics/undergraduate-programs/undergraduate-minors/).

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