COMPUTER SCIENCE, MASTER OF SCIENCE

A focus area or concentration must be chosen for this program.

Admission Requirements

Applicants (degree seeking and special student) must meet the general requirements for admission (https://e-catalogue.jhu.edu/engineering/engineering-professionals/admission-requirements/) to graduate study. The applicant's prior education must include the following prerequisites:

1. One year of calculus (2 semesters or 3 quarters);
2. One semester/term of advanced math (discrete math is strongly preferred but linear algebra and differential equations will be accepted);
3. One semester/term of Java (C++ will be accepted but the student must be knowledgeable in Java);
4. One semester/term of data structures;
5. One semester/term of computer organization (e.g., assembly language and machine organization).

Applicants whose prior education does not include the prerequisites listed above may still enroll under provisional status, followed by full admission status once they have completed the missing prerequisites. Missing prerequisites may be completed with Johns Hopkins Engineering (all prerequisites are available) or at another regionally accredited institution. Admitted students typically have earned a grade point average of at least 3.0 on a 4.0 scale (B or above) in the latter half of their undergraduate studies. Applicants may submit a detailed resume if they would like their academic and professional background to be considered.

Program Requirements

Ten courses must be completed within five years. Students are required to choose a focus area to follow. The curriculum consists of three foundation courses and five courses from the Computer Science program, which includes selected courses from other programs as indicated in the course lists below. At least three courses must be from the same focus area, at least three must be at the 700-level, and at least one 700-level course must be in the chosen focus area. Up to two electives may be selected from outside the Computer Science program and require prior advisor approval. Transfer courses will be considered electives. Transfer courses must meet all general Engineering for Professionals requirements for transfer, must be directly applicable to Computer Science, and will be considered on a case-by-case basis. Only **one** C-range grade (C+, C, or C−) can count toward the master's degree. All course selections outside of the Computer Science program requirements are subject to advisor approval.

Non-degree students in Computer Science should consult with their advisor to determine which courses must be successfully completed before 600- or 700-level Computer Science courses may be taken.

Home-to-Hopkins

Home-to-Hopkins students are permitted to substitute Homewood Campus courses to help meet EP program course requirements. Students should work with their faculty advisor to develop a course plan that will satisfy the degree requirements. Students are required to select the Artificial Intelligence focus area in the Home-to-Hopkins program.

Concentration: Communications and Networking

Ten courses must be completed within five years. The curriculum consists of three foundation courses from the program and seven concentration courses as listed in the Courses by Concentration section, of which a maximum of three may come from the Electrical and Computer Engineering (EN.525.xxx) program. Students are strongly encouraged to take courses from both Computer Science and Electrical and Computer Engineering. Only **one** C-range grade (C+, C, or C−) can count toward the master's degree.

Students lacking an electrical engineering background or equivalent must take EN.525.202 Signals and Systems as an undergraduate prerequisite before taking Electrical and Computer Engineering communications and networking courses.

Concentrations are noted on the student's transcript.

Courses

Code	Title	Credits
Prerequisite Courses (or approved equivalent) [1]		
EN.605.201	Introduction to Programming Using Java	3
EN.605.202	Data Structures	3
EN.605.203	Discrete Mathematics	3
EN.605.204	Computer Organization	3
EN.605.205	Molecular Biology for Computer Scientists	3
Foundation Courses [2,3]		
EN.605.601	Foundations of Software Engineering	3
EN.605.611	Foundations of Computer Architecture	3
EN.605.621	Foundations of Algorithms	3
Focus Areas and Concentrations [4]		
Select one of the following:		
Artificial Intelligence (p. 2)		
Bioinformatics (p. 2)		
Cybersecurity (p. 2)		
Data Communications and Networking (p. 2)		
Data Science and Cloud Computing (p. 2)		
Database Systems and Knowledge Management (p. 3)		
Enterprise and Web Computing (p. 3)		
Human-Computer Interation and Visualization (p. 3)		
Research (p. 3)		
Software Engineering (p. 3)		
Systems (p. 3)		
Theory (p. 3)		
Independent Study (p. 4)		
Communications and Networking Concentration (p. 4)		

[1] Applicants whose prior education does not include the prerequisites listed under Admission Requirements may still be admitted under provisional status, followed by full admission once they have completed the missing prerequisites. All prerequisite courses beyond calculus are available at Johns Hopkins Engineering. These courses do not count toward the degree or certificate requirements.

[2] Students working toward a master's degree in Computer Science are required to take the following three foundation courses before taking any other courses.

[3] One or more foundation courses can be waived by the student's advisor if a student has received an A or B in equivalent graduate courses.

In this case, the student may replace the waived foundation courses with the same number of other graduate Computer Science courses and may take these courses after all remaining foundation course requirements have been satisfied.

[4] Some courses require Calculus III as a prerequisite.

Courses by Focus Area

The focus areas offered represent related groups of courses that are relevant for students with interests in the selected areas. Students are required to choose a focus area to follow and to take at least three courses from the selected focus area, including at least one 700-level course. The focus areas are presented as an aid to students in planning their course selections and are only applicable to students seeking a master's degree. They do not appear as official designations on a student's transcript or diploma.

Artificial Intelligence

Code	Title	Credits
EN.525.670	Machine Learning for Signal Processing	3
EN.525.733	Deep Learning for Computer Vision	3
EN.525.786	Human Robotics Interaction	3
EN.605.613	Introduction to Robotics	3
EN.605.624	Logic: Systems, Semantics, and Models	3
EN.605.645	Artificial Intelligence	3
EN.605.646	Natural Language Processing	3
EN.605.647	Neural Networks	3
EN.605.649	Introduction to Machine Learning	3
EN.605.673	High-Speed Networking Technologies	3
EN.605.745	Reasoning Under Uncertainty	3
EN.605.746	Advanced Machine Learning	3
EN.605.747	Evolutionary and Swarm Intelligence	3
EN.695.637	Introduction to Assured AI and Autonomy	3
EN.705.603	Creating AI-Enabled Systems [4]	3

Bioinformatics

Code	Title	Credits
EN.605.643	Linked Data and the Semantic Web	3
EN.605.651	Principles of Bioinformatics	3
EN.605.652	Biological Databases and Database Tools	3
EN.605.653	Computational Genomics	3
EN.605.656	Computational Drug Discovery,Dev	3
EN.605.657	Statistics for Bioinformatics	3
EN.605.716	Modeling and Simulation of Complex Systems	3
EN.605.751	Algorithms for Structural Bioinformatics	3
EN.605.755	Systems Biology	3
EN.605.759	Independent Project in Bioinformatics	3

Cybersecurity

Code	Title	Credits
EN.605.636	Autonomic Computing	3
EN.605.731	Survey of Cloud Computing Security	3
EN.635.673	Protecting Critical Infrastructure Against Cyber Attacks	3
EN.695.601	Foundations of Information Assurance	3
EN.695.611	Embedded Computer Systems-Vulnerabilities, Intrusions, and Protection Mechanisms	3
EN.695.612	Operating Systems Security	3
EN.695.614	Security Engineering	3
EN.695.615	Cyber Physical Systems Security	3
EN.695.621	Public Key Infrastructure and Managing E-Security	3
EN.695.622	Web Security	3
EN.695.641	Cryptology	3
EN.695.642	Intrusion Detection	3
EN.695.643	Introduction to Ethical Hacking	3
EN.695.711	Java Security	3
EN.695.712	Authentication Technologies	3
EN.695.721	Network Security	3
EN.695.741	Information Assurance Analysis	3
EN.695.742	Digital Forensics Technologies and Techniques	3
EN.695.744	Reverse Engineering and Vulnerability Analysis	3
EN.695.749	Cyber Exercise	3
EN.695.791	Information Assurance Architectures and Technologies	3

Data Communications and Networking

Code	Title	Credits
EN.605.671	Principles of Data Communications Networks	3
EN.605.674	Network Programming	3
EN.605.675	Protocol Design	3
EN.605.677	Internetworking with TCP/IP I	3
EN.605.771	Wired and Wireless Local and Metropolitan Area Networks	3
EN.605.772	Network Security Management	3
EN.605.776	Fourth Generation Wireless Communications: WiMAX and LTE	3
EN.605.777	Internetworking with TCP/IP II	3
EN.605.779	Network Design and Performance Analysis	3
EN.525.678	Next Generation Mobile Networks and Security with 5G	3
EN.525.768	Wireless Networks	3

Data Science and Cloud Computing

Code	Title	Credits
EN.605.631	Statistical Methods for Computer Science	3
EN.605.632	Graph Analytics	3
EN.605.633	Social Media Analytics	3
EN.605.634	Crowdsourcing and Human Computation	3
EN.605.635	Cloud Computing	3
EN.605.649	Introduction to Machine Learning	3
EN.605.662	Data Visualization	3
EN.605.724	Applied Game Theory	3
EN.605.731	Survey of Cloud Computing Security	3
EN.605.741	Large-Scale Database Systems	3
EN.605.744	Information Retrieval	3
EN.605.746	Advanced Machine Learning	3
EN.605.788	Big Data Processing Using Hadoop	3
EN.625.734	Queuing Theory with Applications to Computer Science	3

Code	Title	Credits
EN.625.741	Game Theory	3
EN.685.648	Data Science [4]	3

Database Systems and Knowledge Management

Code	Title	Credits
EN.605.624	Logic: Systems, Semantics, and Models	3
EN.605.641	Principles of Database Systems	3
EN.605.643	Linked Data and the Semantic Web	3
EN.605.644	XML Design Paradigms	3
EN.605.645	Artificial Intelligence	3
EN.605.646	Natural Language Processing	3
EN.605.647	Neural Networks	3
EN.605.649	Introduction to Machine Learning	3
EN.605.741	Large-Scale Database Systems	3
EN.605.742	Deep Neural Networks	3
EN.605.744	Information Retrieval	3
EN.605.745	Reasoning Under Uncertainty	3
EN.605.746	Advanced Machine Learning	3
EN.605.747	Evolutionary and Swarm Intelligence	3
EN.685.648	Data Science [4]	3
EN.525.643	Real Time Computer Vision	3
EN.525.733	Deep Learning for Computer Vision	3
EN.705.601	Applied Machine Learning [4]	3

Enterprise and Web Computing

Code	Title	Credits
EN.605.681	Principles of Enterprise Web Development	3
EN.605.682	Web Application Development with Java	3
EN.605.683	Java Enterprise Development: Processes, Tools and Infrastructure	3
EN.605.684	Agile Development with Ruby on Rails	3
EN.605.686	Mobile Application Development for the Android Platform	3
EN.605.687	Mobile Application Development for the iOS Platform	3
EN.605.784	Enterprise Computing with Java	3
EN.605.786	Enterprise System Design and Implementation	3
EN.605.787	Front End Web App Development	3
EN.605.788	Big Data Processing Using Hadoop	3
EN.605.789	Service API Design and Development	3
EN.635.683	E-Business: Models, Architecture, Technologies, and Infrastructure	3

Human–Computer Interaction and Visualization

Code	Title	Credits
EN.605.661	Computer Vision	3
EN.605.662	Data Visualization	3
EN.605.667	Computer Graphics	3
EN.605.668	Computer Gaming Engines	3
EN.605.767	Applied Computer Graphics	3
EN.605.634	Crowdsourcing and Human Computation	3
EN.635.661	Principles of Human Computer Interaction	3

Research

Code	Title	Credits
EN.605.646	Natural Language Processing	3
EN.605.728	Quantum Computation	3
EN.605.745	Reasoning Under Uncertainty	3
EN.605.746	Advanced Machine Learning	3
EN.605.747	Evolutionary and Swarm Intelligence	3
EN.605.795	Capstone Project in Computer Science	3
EN.605.801	Independent Study in Computer Science I	3
EN.605.802	Independent Study in Computer Science II	3
EN.615.781	Quantum Information Processing	3
EN.635.673	Protecting Critical Infrastructure Against Cyber Attacks	3
EN.695.722	Covert Channels	3

Software Engineering

Code	Title	Credits
EN.605.601	Foundations of Software Engineering	3
EN.605.602	Software Analysis and Design	3
EN.605.603	Object-Oriented and Functional Programming in Kotlin	3
EN.605.604	Object-Oriented Programming with C++	3
EN.605.606	Programming with Domain-Specific Languages	3
EN.605.607	Agile Software Development Methods	3
EN.605.608	Software Project Management	3
EN.605.609	DevOps and Secure Software Development	3
EN.605.629	Programming Languages	3
EN.605.701	Software Systems Engineering	3
EN.605.702	Service-Oriented Architecture	3
EN.605.704	Object-Oriented Analysis and Design	3
EN.605.705	Software Safety	3
EN.605.707	Software Patterns	3
EN.605.708	Tools and Techniques of Software Project Management	3
EN.695.744	Reverse Engineering and Vulnerability Analysis	3

Systems

Code	Title	Credits
EN.605.611	Foundations of Computer Architecture	3
EN.605.612	Operating Systems	3
EN.605.613	Introduction to Robotics	3
EN.605.614	System Development in the UNIX Environment	3
EN.605.615	Compiler Design with LLVM	3
EN.605.616	Multiprocessor Architecture & Programming	3
EN.605.617	Introduction to GPU Programming	3
EN.605.715	Software Development for Real-Time Embedded Systems	3
EN.605.716	Modeling and Simulation of Complex Systems	3

Theory

Code	Title	Credits
EN.605.620	Algorithms for Bioinformatics	3
EN.605.621	Foundations of Algorithms	3
EN.605.622	Computational Signal Processing	3
EN.605.624	Logic: Systems, Semantics, and Models	3

EN.605.626	Image Processing	3
EN.605.627	Computational Photography	3
EN.605.629	Programming Languages	3
EN.605.721	Design and Analysis of Algorithms	3
EN.605.724	Applied Game Theory	3
EN.605.727	Computational Geometry	3
EN.605.728	Quantum Computation	3
EN.605.729	Formal Methods	3
EN.625.617	Intro to Enumerative Combinatorics	3
EN.625.687	Applied Topology	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.692	Probabilistic Graphical Models	3
EN.625.734	Queuing Theory with Applications to Computer Science	3
EN.625.741	Game Theory	3

Independent Study

Code	Title	Credits
EN.605.801	Independent Study in Computer Science I	3
EN.605.802	Independent Study in Computer Science II	3
EN.605.795	Capstone Project in Computer Science	3

Courses by Concentration

Communications and Networking Concentration

Code	Title	Credits
Prerequisite		
EN.525.202	Signals and Systems [5]	3
Electives		
Select seven of the following: [6]		
EN.525.608	Next Generation Telecommunications	3
EN.525.614	Probability & Stochastic Processes for Engineers	3
EN.525.616	Communication Systems Engineering	3
EN.525.618	Antenna Systems	3
EN.525.620	Electromagnetic Transmission Systems	3
EN.525.638	Introduction to Wireless Technology	3
EN.525.640	Satellite Communications Systems	3
EN.525.641	Computer and Data Communication Networks I	3
EN.525.678	Next Generation Mobile Networks and Security with 5G	3
EN.525.707	Error Control Coding	3
EN.525.708	Iterative Methods in Communications Systems	3
EN.525.722	Wireless and Mobile Cellular Communications	3
EN.525.735	MIMO Wireless Communications	3
EN.525.738	Advanced Antenna Systems	3
EN.525.747	Speech Processing	3
EN.525.751	Software Radio for Wireless Communications	3
EN.525.754	Wireless Communication Circuits	3
EN.525.759	Image Compression, Packet Video, and Video Processing	3
EN.525.761	Wireless and Wireline Network Integration	3
EN.525.768	Wireless Networks	3
EN.525.771	Propagation of Radio Waves in the Atmosphere	3
EN.525.772	Fiber-Optic Communication Systems	3

EN.525.776	Information Theory	3
EN.525.783	Spread Spectrum Communications	3
EN.525.789	Advanced Satellite Communications	3
EN.525.791	Microwave Communications Lab	3
EN.525.793	Advanced Communication Systems	3
EN.605.671	Principles of Data Communications Networks	3
EN.605.674	Network Programming	3
EN.605.675	Protocol Design	3
EN.605.677	Internetworking with TCP/IP I	3
EN.605.771	Wired and Wireless Local and Metropolitan Area Networks	3
EN.605.772	Network Security Management	3
EN.605.776	Fourth Generation Wireless Communications: WiMAX and LTE	3
EN.605.777	Internetworking with TCP/IP II	3
EN.695.601	Foundations of Information Assurance	3
EN.695.622	Web Security	3
EN.695.721	Network Security	3

[5] This course does not count toward degree or certificate requirements.

[6] No more than three courses may come from Electrical and Computer Engineering 525.XXX.

Please refer to the course schedule (ep.jhu.edu/schedule (https://apps.ep.jhu.edu/schedule/search/)) published each term for exact dates, times, locations, fees, and instructors.