



Department of Computer
Science

Master of Science Handbook

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GRADUATE STUDY IN COMPUTER SCIENCE

**Department of Computer Science
Howard University
Washington, DC 20059**

Revised October 2015

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This is an electronic version of our printed admissions brochure, which is updated once a year. If, after reading this brochure you cannot find answers to all of your questions, or need more information, please contact us at 202-806-4822 Mondays through Fridays from 9 a.m. - 4 p.m. Eastern Standard Time, or send e-mail to jtrimble.howard.edu.

For the most up-to-date admissions information please visit our Graduate School Admissions Web pages: www.gs.howard.edu

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OUR DEPARTMENT AND THE COMMUNITY

The University and Community

Howard University is a comprehensive, research-oriented, historically black private university providing an educational experience of exceptional quality to students of high academic potential. Further, the University is dedicated to attracting and sustaining a cadre of faculty who are, through their teaching and research, committed to the development of distinguished and compassionate graduates and to the quest for solutions to human and social problems in the United States and throughout the world. This mission of the University is central to everything we do and can be found in a 1989 resolution of the Board of Trustees. With its reputation for providing high-quality education at an affordable price, Howard is consistently ranked one of the nation's very best universities. Of the approximately 10,000 students enrolled, around 4,000 are graduate and professional students.

Washington DC is the capital city of the United States of America. The city and the surrounding area offer many cultural advantages, including its well-known monuments and inspiring memorials, and an excellent array of theater and music. The metropolitan area has a population over one million.

Our Department

The **Department of Computer Science** at Howard is one of the first to be created in a historically black college and university (HBCU). The department's primary missions is to expand and diversify the pool of qualified individuals in the computing profession and to advance knowledge in computer science by providing high quality instruction and conducting research that addresses technical challenges and societal problems.

The Department of Computer Science will be the department of choice for students seeking high-quality undergraduate and graduate degree programs in computer science. The Department will be recognized across the nation and the global community for research and education that produces diverse and versatile professionals. Graduates from our department will be able to:

- analyze, design, implement, and evaluate a computerized solution to a real life problem using appropriate tools;
- work effectively as a team member;
- enter a professional computer science position or enter an appropriate graduate program;
- communicate effectively through speaking, writing, and the use of presentation tools;
- adapt to technological changes and innovations in the discipline;
- consider the ethical and societal concerns related to computers in society and apply this knowledge in the conduct of their careers.

The department offers a traditional B.S. degree in computer science, a computer science minor option for non-engineering disciplines at Howard, a graduate certificate course in Cybersecurity, a traditional M.S. degree in computer science, an accelerated 1-year M.S. degree in computer science and a PhD in computer science. **The B.S. curriculum** is a traditional computer science

degree. The M.S. curriculum is oriented toward the design and application of computer systems and toward that portion of software engineering that guides and supports practice. The graduate certificate program prepares professionals in computer science and related areas to assume positions in secure systems development and managing the critical information security infrastructures in today's organizations. The **M.S. program** prepares highly competent and broadly skilled practitioners. A majority of the master's graduates work in industry, in companies ranging from small start-up operations to government labs and large research and development corporations. The **Ph.D. program** will prepare teachers and researchers for positions with universities, government research laboratories, and industry. Academic employment ranges from four-year colleges, where teaching is the primary focus, to positions at major research universities.

Currently, our faculty includes 13 tenured and tenure-track faculty, 3 adjuncts, and 2 lecturers. We also have a technical and administrative support staff (3 people). Most of our graduate students are full time. Students contribute to nearly every aspect of the department's operation. In addition to taking a wide variety of courses, they have the opportunity to participate in groundbreaking research, to teach, and to attend research group meetings. The local chapter of the Association of Computing Machinery (ACM), and the Upsilon Pi Epsilon (UPE) honor society sponsors both professional and social events. Students are strongly encouraged to seek membership of these organizations, however, membership of UPE is by invitation only.

Our student population is very diverse in terms of both geographic origin and previous degrees. While computer science, information systems, and mathematics represent the largest number of undergraduate majors among our graduate students, others majored in physics and engineering.

Our Faculty

For more details: <http://www.cs.ceacs.howard.edu/faculty>

Peter Keiller, Associate Professor; D.Sc., George Washington University, 1996. Software engineering process, reliability engineering, software testing, software fault tolerance, statistical modeling and analysis, performance modeling.

Todd Shurn, Associate Professor; Ph.D., Southern Methodist University, 1994. Combinatorial optimization, heterogeneous data communication networks, web services and interoperability, interdisciplinary multi-media applications, gaming.

Harry Keeling, Associate Professor and Director of Undergraduate Admissions; Ph.D., George Mason University, 1998. Intelligent tutoring systems, machine learning, artificial intelligence, intelligent agents, web-based technology, and expert systems.

Legend L. Burge III, Professor and Chair; Ph.D., Oklahoma State University, 1998. Parallel and distributed computing, operating systems, and computer networking.

Gedare Bloom, Assistant Professor; Ph.D., George Washington University, 2013. Embedded Systems, Computer Security, Cyber-physical systems, operating systems, computer architecture.

Moses Garuba, Professor and Director of Graduate Admissions; Ph.D., University of London, 2000. Information security, database security, secure electronic transactions, distributed algorithms, formal methods, computer forensics.

Jiang Li, Associate Professor; Ph.D., Rensselaer Polytechnic Institute, 2003. Computer networking, network security, network simulation, data communications, wireless/mobile networking, and sensor networks.

Gloria Washington, Assistant Professor; Ph.D., George Washington University, 2011. Human-Computer Interaction, Human-centered computing, affective computing, biometrics.

Chunmei Liu, Professor; Ph.D., University of Georgia, 2006. Bioinformatics, computational biology, algorithms, graph theory.

Mugizi Robert Rwebangira, Assistant Professor; Ph.D., Carnegie Mellon University, 2009. machine learning, algorithms, data mining and analysis.

Wayne Patterson, Professor; Ph.D., University of Michigan, Ann Arbor, 1971. Computer security, cryptology, computational science, parallel computing.

Adjunct Faculty

Reginald Hobbs, Assistant Professor; Ph.D., Georgia Institute of Technology, 2005. Software engineering, programming languages, knowledge engineering, knowledge management.

Bernard Woolfolk, Instructure, M.S., George Washington University, 1990. Object-oriented design, software engineering.

Jamika Burge, Assistant Professor; Ph.D., Virginia Technology, 2007. Human-Computer Interaction, Human-centered computing, Computer Science Education, Social Computing.

Torrance Fennell, Instructor; M.S., University of Maryland University College, 2001. Computer Networking, Telecommunications, Wireless Networking.

Emeritus

Don Coleman, Professor Emeritus; Ph.D., University of Michigan, 1971. Fault tolerant software, systems engineering, software engineering, software reliability, software metrics, simulation of parallel processes, user interfaces.

Ronald Leach, Professor Emeritus; Ph.D., University of Maryland, College Park, 1971. Software engineering, software reuse, software measurement and metrics, software fault-tolerance, software testing, operating systems, and computer science education.

Arthur Paul, Professor Emeritus; Ph.D., University of Virginia, 1983. Large-scale systems design, systems engineering, and technology transfer and commercialization.

John Trimble, Professor Emeritus; Ph.D., Georgia Institute of Technology, 1992. System dynamics, expert systems, software engineering, modeling and simulation, knowledge management, appropriate technology.

Wolsey Semple, Professor Emeritus; MS., Massachusetts Institute of Technology, 1961. Computer Graphics, Systems Operations.

Research Areas

Our faculty conducts research in a broad range of research areas. Following is a quick reference index to their interests.

Algorithms and Complexity Theory

Chunmei Liu, Robert Rwebangira, Wayne Patterson

Artificial Intelligence

Harry Keeling, Reginald Hobbs, Robert Rwebangira

Bioinformatics and Computational Biology

Chunmei Liu, Legand Burge, Robert Rwebangira

Computer Architectures

Legand Burge, Jiang Li, Gedare Bloom

Databases and Data Visualization and Analysis

Moses Garuba, Peter Keiller, Robert Rwebangira

Data Communications and Networking

Jiang Li, Gedare Bloom, Legand Burge, Todd Shurn,

Distributed/Parallel Computation and Operating Systems

Legand Burge, Moses Garuba, Gedare Bloom, Jiang Li, Torrence Fennell

Information Assurance and Computer Security

Gloria Washington, Gedare Bloom, Jiang, Li, Moses Garuba, Wayne Patterson, Legand Burge

Mobile Computing

Legand Burge, Gloria Washington, Jiang Li

Multimedia Systems, Gaming, and WWW Applications

Todd Shurn, Legand Burge, Gloria Washington

Human-Computer Interaction ,Human-Centered Computing

Gloria Washington, Jamika Burge

Performance Modeling and Simulation

Peter Keiller, Legand Burge, Gedare Bloom, Gloria Washington, Jiang Li

Software Engineering and Environments

Peter Keiller, Gloria Washington

Systems Engineering

Peter Keiller

Faculty Contact Information

Department Chair

Legand Burge, Professor	blegand@scs.howard.edu http://www.cs.ceacs.howard.edu/users/blegand	(202) 806-4852	2120B Downing Hall
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Graduate Program Director and Director of Information Security Certificate Program

Jiang Li, Associate Professor	lij@scs.howard.edu http://www.cs.ceacs.howard.edu/users/jli	(202) 806-4861	2038B Downing Hall
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Undergraduate Program Director

Harry Keeling, Associate Professor	hkeeling@howard.edu http://www.cs.ceacs.howard.edu/users/hkeeling	(202) 806-4830	2040 Downing Hall
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Faculty:

Robert Rwebangira, Assistant Professor	rweba@scs.howard.edu http://www.cs.ceacs.howard.edu/users/mrwebangira	(202) 806-6595	2120B Downing Hall
Peter Keiller, Associate Professor	pk@scs.howard.edu http://www.cs.ceacs.howard.edu/users/pkeiller	(202) 806-4828	2112 Downing Hall
Todd Shurn, Associate Professor	shurn@scs.howard.edu http://www.cs.ceacs.howard.edu/users/tshurn	(202) 806-4824	1110 Downing Hall
Moses Garuba, Professor	moses@scs.howard.edu http://www.cs.ceacs.howard.edu/users/mgaruba	(202) 806-4371	B36B Mackey
Wayne Patterson, Professor	wpatterson@howard.edu http://www.cs.ceacs.howard.edu/users/wpatterson	(202) 806-4686	2120B Downing Hall
Gedare Bloom, Assitant	gedare@scs.howard.edu http://www.cs.ceacs.howard.edu/users/gedare	(202) 806-4822	2038A Downing

Professor			Hall
Gloria Washington, Assistant Professor	gwashington@scs.howard.edu http://www.cs.ceacs.howard.edu/users/gwashington	(202) 806-7417	1110 Downing Hall
Chunmei Liu, Professor	chunmei@scs.howard.edu http://www.cs.ceacs.howard.edu/users/cliu	(202) 865-0056	2038A Downing Hall

DEGREE PROGRAMS AND ADMISSIONS INFORMATION

Overview of Degree Programs and Requirements

The department offers a one-year accelerated Master of Computer Science degree program, the traditional Master of Computer Science degree program, and a Cybersecurity Graduate Certificate course. The accelerated program is only open to exceptional students in our undergraduate degree program with at least a GPA of 3.3 on a 4.0 scale, and that are involved in undergraduate research. These students must apply in the fall semester of their junior year, and if admitted, will be expected to take the indicated graduate courses during their senior year. Because of the additional graduate coursework taken as an undergraduate, only 30 credit hours are required for students in the accelerated program. The Certificate in Cybersecurity program is open to new entrants, graduate students, and undergraduate seniors.

Master of Computer Science (Accelerated and Traditional)

The Master of Science program in the Computer Science Department provides intensive preparation in the concepts and techniques related to the design, programming, and application of computing systems. The program requires the student to take a broad spectrum of courses, while simultaneously allowing for emphasis in desired areas of specialization. The Computer Science Department at Howard University offers the following computer science specializations:

- Software engineering,
- Information security,
- Artificial intelligence,
- Computer Networks,
- Computing systems.

Masters Admission Requirements

1. A bachelor's degree in computer science, information systems, mathematics, or engineering from an accredited college or university.
2. At least one year of programming courses. Applicants should possess a working knowledge of at least two high-level programming languages. At least one of these languages should be C, C++ or Java;

3. A course in data structures in which the student is taught the basic data structures of linked lists, stacks, queues, and trees. The student should have extensive experience in writing programs that implement algorithms for manipulating these data structures;
4. An additional course involving machine organization. This requirement can be fulfilled by a course in operating systems, assembly language programming, computer organization, computer architecture, or similar courses;
5. At least one course in computer science having the data structures course as a prerequisite. This requirement can be fulfilled by a course in algorithms, algorithm analysis, numerical analysis, or a similar course.
6. One semester of operating systems;
7. One semester of an algorithms course;
8. Either one semester of probability and statistics or an equivalent course;
9. One year of calculus;
10. One semester of upper-level courses in differential equations, linear algebra, abstract algebra, or discrete mathematics. The course should have calculus as a prerequisite;
11. Applicants should also satisfy all admission requirements of the graduate school.

NOTE:

Students who do not meet all of the provisions indicated above may be admitted provisionally to the graduate program if they show promise of being able to complete the MS program within a reasonable time. Students admitted provisionally should recognize that it will take them considerably longer to obtain a graduate degree because of the need to take some of the basic courses described above. Students should also recognize that many of these courses are to be taken sequentially. Thus, a student without any computer science courses may need up to two years of course work before he or she is able to begin graduate courses.

Masters Degree Requirements

For the Master of Computer Science degree, a student must attend the Responsible Conduct of Research Workshop, attend a 1-month workshop on Research Methods, take the Expository Writing Exam, and complete at least 33 credit hours, which are to be taken as follows.

- a) Each student must take the following core courses totaling **15 credits**:
 - **CSCI 570** Advanced Algorithms
 - **CSCI 551** Advanced Software Engineering I
 - **CSCI 510** Computer Architecture
 - **CSCI 572** Computability and Complexity
 - **CSCI 680** Advanced Operating Systems

- b) Each student must choose either of the following two options.
 - i. **Thesis Option:** comprised of 27-credits of courses and 6-credit hours of CSCI-699 (Master's Thesis). Students selecting the Thesis option must obtain an advisor in the Department of Computer Science. With the help of this advisor, the student must select a Thesis Committee. The majority of the committee must be faculty in the Computer Science department. The student must write a Master's thesis that satisfies the requirements of the advisor and the Graduate School. The student should note that a grade of "A" in CSCI-699 cannot be used to balance a grade of "C" in another course. The student must therefore maintain a grade point average of at least "B" in non-thesis courses in order to graduate. See the Graduate Bulletin for more information on this point and on any other factors related to graduate studies at Howard University.
 - ii. **Project Option:** comprised of 27-credits of courses, a minimum of 3-credit hours of CSCI-652 (Special Topics), 3-credit hours of Masters Project, and a written comprehensive examination‡. No hours from CSCI-699 (Master's Thesis) may be counted as part of the 30 hours. Students selecting the project option must obtain a project advisor in the Department of Computer Science. Students taking CSCI-652 must produce a symposium, workshop, conference, or journal article as a deliverable.

- c) Each student must meet the computer science depth requirement by completing a minimum of three courses in one of the following areas of specialization.

- d) Each student must meet the computer science breadth requirement by completing a minimum of one course in an area other than their depth area.

AREAS OF SPECIALIZATION

Software Engineering:

- **CSCI 552** Advanced Software Engineering II
- **CSCI 540** Object-Oriented Development
- **CSCI 683** Special Topics in Software Engineering

Cybersecurity:

- **CSCI 653** Cybersecurity I

- **CSCI 654** Cybersecurity II
- **CSCI 659** Capstone in Security
- **CSCI 684** Special Topics in Cybersecurity

Artificial Intelligence:

- **CSCI 660** Artificial Intelligence
- **CSCI 651** Expert Systems
- **CSCI 673** Knowledge Engineering and Management
- **CSCI 685** Special Topics in Artificial Intelligence

Computer Networks

- **CSCI 548** Data Communications I
- **CSCI 549** Data Communications II
- **CSCI 550** Network Modeling and Analysis
- **ECE 487** Telecommunications
- **ECE 460** Wireless Communications
- **CSCI 686** Special Topics in Data Communications

Computing Systems:

- **CSCI 560** Performance Modeling
- **CSCI 682** Parallel Computing
- **CSCI 634** Advanced Modeling and Simulation
- **CSCI 674** Advanced Systems Management and Analysis
- **ECE 416** Microprocessors and Microcomputers
- **ECE 420** Introduction to VLSI design
- **CSCI 687** Special Topics in Computer Systems

- e) **Responsible Conduct of Research Workshop Requirement.** Each student is required to take the Responsible Conduct of Research Workshop in the first semester of the graduate program. Attending and participating in this workshop is a requirement for all degrees offered by the Graduate School, including the Master of Computer Science. Details on this program, including registration, dates, and times can be found at the Graduate School's web site.
- f) **Expository Writing Requirement.** Each student is required to take the Expository Writing Examination in the first semester of the graduate program. Passing an Expository Writing Examination is a requirement for all degrees offered by the Graduate School, including the Master of Computer Science. Details on this program, including seminars for preparation to take the exam, examination dates, registration for the examination, and courses/workshops can be found at the Graduate School's web site.

Electives

- **CSCI 632** Advanced Database Systems
- **CSCI 574** Computational Biology

- **CSCI 532** Advanced Operations Research
- **CSCI 655, 656,657,658,659** Special Topics
- **CSCI 599** Masters Project
- **CSCI 699** Masters Thesis

Important Notes:

- Additional courses to be taken in Computer Science, Mathematics, Engineering, Business, or Fine Arts require the consent of the Graduate Advisor in the Department of Computer Science.
- A maximum of two courses taken at other universities, or outside the graduate courses in the Department of Computer Science, may be counted toward the degree.
- ‡Comprehensive Exam (Masters Project Option only). The exam will consist of five two-hour tests, with each test covering one of the five core areas. For each core area that is tested, a student must score a minimum of 85% to obtain a high pass and a minimum of 70% to obtain a low pass. At a minimum, a student must get a high pass three of the five core areas. The exam will be offered once at the beginning of the Fall/Spring semesters. There is no limit as to how many times a student can take the exams. However, students can only take the exam at most once per semester.

Graduate Curriculum Sequence (Traditional Student Entering Fall)

YEAR	FALL	Credits	SPRING	Credits
1	Computer Architecture	3	Advanced Operating Systems	3
	Advanced Algorithms	3	Computability and Complexity	3
	Adv. Software Engineering	3	<depth>	3
		9		9
2	<breadth>	3	<depth>	3
	<depth>	3	Thesis or “Masters Project†”	3
	Thesis or “Special Topics”	3		6*
		9*		
			Total Credits	33

Note: *This may require students in their last semester to enroll in an additional 3 credit course in order to remain full time.

Graduate Curriculum Sequence (5-year Masters Program)

YEAR	FALL	Credits	SPRING	Credits
Senior	CSCI-570 Adv. Algorithms **	3	CSCI 680 Adv. Operating Systems *	3
	CSCI-401-Operating systems	3	CSCI 572 Computability & Complexity **	3
	CSCI-410 Mod & Simulation	3	CSCI-472 Systems Mgmt Analysis	3
	CSCI-491 Senior Project I	2	Non-technical elective	3
	Non-technical elective	3	CSCI-492 Senior Project II	2

	<technical elective>	3		Non-technical elective	3
		17			17

YEAR	FALL	Credits		SPRING	Credits
2	Thesis or “Special Topics”	3		Thesis or “Masters Project†”	3
	CSCI-551 Adv. Soft Engg	3		<depth>	3
	Computer Architecture	3		<depth>	3
	<depth>	3		<breadth>	3
		12			12
				Total Credits	33

Note:

†Requires Comprehensive Exam (Offered beginning of every Fall/Spring Semester)

*Senior year technical electives (students complete 33 credits of graduate courses)

**Transfer Credits (only 30 graduate credits are used toward Masters)

Plan of Study

In collaboration with their individual advisor, all Ph.D. students must complete the deliberation of their study plan and submit it to the director of graduate by the beginning of the second semester being in the program. The plan shows how a student should progress through the program toward the degree, such as when to take which courses, whether to do thesis or project, when to take the comprehensive exams if necessary, and so on. The plan of study should be signed by the advisor of the student before submission, and be approved by the director of graduate studies.

Once submitted and approved, the student should follow the plan unless catastrophic situation occurs. Minor revisions are allowed and should be approved by both the advisor and the director of graduate studies. Major revisions may result in disruption of the study and are strongly discouraged.

Certificate in Cybersecurity

Cybersecurity has become an increasingly important area of study within the discipline of computer science, especially in view of the increased demands for national and international security. The Graduate Certificate in Cybersecurity is designed to provide existing graduate students with a significantly enhanced tool for marketability in the Cybersecurity industry. The Graduate Certificate in Cybersecurity is an academic offering that is now designated by the National Security Agency as a Center of Academic Excellence in Information Assurance Education (CAE/IAE). See <http://www.howard.edu/csl>.

The interdisciplinary program is comprised of the curriculum in the Department of Computer Science. Courses can be used towards the Master's degree program in computer science to provide a continuous path for the student towards a master degree.

The Certificate program requires 15 credits, including a year-long course in Cybersecurity, two additional technical courses, and a capstone project course.

Certificate Admission Requirements

Students Already Enrolled

- Good academic standing
- A minimum of 6 eligible credits (as determined by the Department of Computer Science)

Students Not Already Enrolled

- Satisfactory completion of regular degree requirements

Requirement Exceptions

- No Graduate Record Examination
- Other specific requirements of the Department

Program Requirements

- 15 credit hours as follows:
 - **CSCI 653** Computer Security I
 - **CSCI 654** Computer Security II
 - **Two courses from the following**
 - CSCI 548 Data Communications I
 - CSCI 549 Data Communications II
 - CSCI 632 Advanced Database Systems
 - CSCI 680 Advanced Operating Systems
 - CSCI 684 Special Topics in Cybersecurity
 - **CSCI 659** Capstone in Security
- Demonstration of the same level of achievement as degree seeking students
- Maintenance of at least a B grade in each course

Advanced Undergraduate courses

These may be taken for graduate credit with the written permission of the student's Graduate Advisor. At most two such courses may be taken for graduate credit towards the degree of Master of Science.

CSCI-402	Mobile Application Development	3 Credits
CSCI-421	Computer & Video Game development	3 Credits
CSCI-475	Intro to Machine Learning	3 Credits
CSCI-480	Digital Media and Multimedia Applications	3 Credits
CSCI- 422	Game Engine Programming	3 Credits

Graduate Courses

CSCI-510	Computer Architecture	3 Credits
This course aims to build on a prior knowledge of computer organization by exploring more advanced concepts related to the design of computer systems and components. Topics include processor design, instruction set design, and addressing; control structures and microprogramming; memory management, caches, and memory hierarchies; and interrupts and I/O structures.		
CSCI-570	Advanced Algorithms	3 Credits
This is a theoretical and advanced course in algorithms; it will present useful techniques for solving challenging programming problems, using efficient algorithms and data structures. It will also provide advanced techniques in the analysis of algorithms and the fine-tuning of algorithms to particular systems to improve performance.		
CSCI-551	Advanced Software Engineering I	3 Credits
This course aims to develop the broad understanding of the discipline of software engineering (gained in the earlier Software Engineering course) by considering the wider systems engineering context in which software plays a role. It aims to examine the concepts and techniques associated with a number of advanced and industrially relevant topics, relating to both the product and processes of software engineering.		

CSCI-520	Computability and Complexity	3 Credits
<p>This course explores the relationship between problems, algorithms, and languages. Computability: finite automata, rewriting systems, Turing machines (linear speedup, robustness, and the Universal Turing machine). It presents recursive and recursively enumerable languages, the Church-Turing thesis, and complexity classes defined in terms of time, space, and circuits.</p>		
CSCI-680	Advanced Operating Systems	3 Credits
<p>This course presents an exciting range of materials from the broad field of operating systems, including basic operating system structure, file systems and storage servers, memory management techniques, process scheduling and resource management, threads, distributed systems, security and a few other advanced topics. It will also examine influential historical systems, important current efforts, extracting lessons both on how to build systems as well as how to evaluate them.</p>		
CSCI-632	Advanced Database Systems	3 Credits
<p>This course presents advanced database system design and implementation. It will start with the basic relational databases and then cover advanced topics in modern database systems, including object-oriented databases, XML databases, distributed databases, and on-line analytical processing. It will also present various data description and query languages, database design, and query processing and optimization, and also look at distributed object model, and data mining and data warehouses.</p>		
CSCI-634	Computer Simulation and Modeling	3 Credits
<p>This course will provide students with the ability to model, simulate and analyze complex systems in a reasonable time. This course is divided into three parts and covers advanced techniques in simulation model design, model execution and model analysis. A selection of model design techniques such as conceptual models, declarative models, functional models, constraint models, and multi-models will be introduced.</p>		
CSCI-548	Data Communications I	3 Credits
<p>Includes data communications media, the ISO network model, network systems elements, local and large scale networks, and line protocols. Students will monitor performance of local area networks using appropriate hardware and will simulate some of the problems of network noise, excess traffic, performance of bridges and gateways, etc. in software. Requires the completion of a group or individual project involving the design, development and demonstration of a communication system and its protocols.</p>		
CSCI-549	Data Communications II	3 Credits
<p>This course is a continuation of Data Communications I. It introduces further networking topics by discussing wireless networking, and the components of network management – fault management, performance, configuration, security and accounting.</p>		

CSCI-549	Computational Biology	3 Credits
<p>Introduces computational methods for understanding biological systems at the molecular level. Problem areas such as mapping and sequencing, sequence analysis, structure prediction, phylogenic inference, regulatory analysis. Techniques such as dynamic programming, Markov models, expectation-maximization, local search.</p>		
CSCI-575	Intro. To Machine Learning	3 Credits
<p>Techniques for learning from data and applying these algorithms to application settings. Topics covered include Bayesian methods, linear classifiers such as the perceptron, regression, and non-parametric methods such as k-nearest neighbors.</p>		
CSCI-653	Cybersecurity I	3 Credits
<p>This course will provide an intensive overview of the field of cryptography, providing a historical perspective on early systems, building to the number theoretic foundations of modern day cryptosystems. Students will study how cryptosystems are designed, to match cryptosystems to the needs of an application, and basic cryptanalysis. Real life breaches of common cryptosystems will be presented to better convey the dangers that lurk in cryptosystem design and in the design of systems that rely on cryptography.</p>		
CSCI-654	Cybersecurity II	3 Credits
<p>This course is a continuation of Computer Security I. It will present security policies, models, and mechanisms for secrecy, integrity, and availability. Topics include operating system models and mechanisms for mandatory and discretionary controls; data models, concepts, and mechanisms for database security; basic cryptography and its applications; security in computer networks and distributed systems; and control and prevention of viruses and other rogue programs.</p>		
CSCI-552	Advanced Software Engineering II	3 Credits
<p>This course is a continuation of the course CSCI-551 (Software Engineering I). The emphasis of the course is on software engineering. Topics covered include verification, metrics, software fault tolerance, maintainability and reliability. Extensive use of the formal properties of algorithms is made. Prerequisite: CSCI-551 (Software Engineering I).</p>		
CSCI-650	Artificial Intelligence	3 Credits
<p>This course presents an overview of artificial intelligence and a survey of the major areas of the field. Course objectives are to study the various knowledge representation methods and techniques in solving AI problems in the literature, gain a level of proficiency in LISP that will enable the student to program an AI problem; design a solution to an AI problem using LISP or a specialized AI language.</p>		
CSCI-651	Expert Systems	3 Credits
<p>This course presents an overview of expert systems and a survey of the major areas of the field. Course objectives are to study the various knowledge representation methods and techniques in solving expert systems problems in the literature, in order to design and implement solutions to problems in specific application domain. Prerequisite: CSCI 650, Artificial Intelligence.</p>		

CSCI 532	Advanced Operations Research	3 Credits
<p>This course will acquaint students with the formulation, solution, and implementation of operations research models for analyzing complex systems in industry or government, also familiarizing students with special techniques of the field such as linear programming and network analysis. Topics include Simplex Method, Duality Theory, and Network Analysis.</p>		
CSCI-540	Object-Oriented Development	3 Credits
<p>This course will provide a fundamental understanding of the object-oriented paradigm, and how it is used in analysis, requirement specification, design, and programming. Emphasis is on object-oriented design. Covers different specification techniques with a focus on the unified modeling language. Object-oriented databases, object-oriented user interfaces and object-oriented business processes, as well as standards in object orientation will be introduced.</p>		
CSCI-550	Network Modeling and Analysis	3 Credits
<p>This course presents various topics related to the design, modeling, and analysis of telecommunication networks, including queuing models, loss systems, overflow systems, simulations, and routing strategies. Emphasis will be placed on exact and approximate methods for measuring the performance of such networks. Upon completion of this course, students will be able to apply modeling techniques to telecommunication networks, based on specific characteristics, and measure the performance of each using both exact and approximate methods.</p>		
CSCI-682	Parallel Computing	3 Credits
<p>This course aims at exploring several alternative programming models and contrasting their suitability for different architectures and applications. The material covered will encompass topics in parallel computer architectures, parallel programming models, and languages. Appropriate examples for existing or proposed parallel architectures will be surveyed. Alongside, students will have the opportunity to gain hands-on experience with MPI and PVM.</p>		
CSCI-685	Special Topics in Software Engineering	
<p>This course will present special research projects in software engineering for students who wish to independently pursue reading and study in a topic mutually agreed upon by a member of the faculty and the student. Prerequisite: permission of the Chair of the Department of Computer Science.</p>		
CSCI-686	Special Topics in Cybersecurity	
<p>This course will present special research projects in information security for students who wish to independently pursue reading and study in a topic mutually agreed upon by a member of the faculty and the student. Prerequisite: permission of the Chair of the Department of Computer Science.</p>		
CSCI 685	Special Topics in Artificial Intelligence	
<p>This course will present special research projects in Artificial Intelligence for students who wish to independently pursue reading and study in a topic mutually agreed upon by a member of the faculty and the student. Prerequisite: permission of the Chair of the Department of Computer Science.</p>		

CSCI 686	Special Topics in Data Communications	
<p>This course will present special research projects in Data Communications for students who wish to independently pursue reading and study in a topic mutually agreed upon by a member of the faculty and the student. Prerequisite: permission of the Chair of the Department of Computer Science.</p>		
CSCI 687	Special Topics in Computer Systems	3 Credits
<p>This course will present special research projects for students who wish to independently pursue reading and study in a topic mutually agreed upon by a member of the faculty and the student. Prerequisite: permission of the Chair of the Department of Computer Science</p>		
CSCI-659	Capstone in Security	3 Credits
<p>This course is the terminal project for the Information Security Certificate program. It requires the design, implementation, setup and configuration of realistic enterprise computing applications and environments. Securing the infrastructure and integration of different services and technology in efficient, secured and redundant manners, and utilizing open-source and commercial security products.</p>		
CSCI 673	Knowledge Engineering and Management	3 Credits
<p>Knowledge Engineering is the process of building and maintaining Knowledge structures, particularly intelligent problem-solving systems. Knowledge management is concerned with collecting and making accessible the knowledge structures most relevant to a particular set of stakeholders. This course covers selected methods from different areas of Knowledge Engineering and knowledge management. Topics include knowledge representation and reasoning, knowledge acquisition, knowledge synthesis and knowledge evolution.</p>		
CSCI-599	Master's Project	3 Credits
<p>This is the terminal work for the non-thesis option of the master's degree program. It affords the opportunity to conduct applied research, design, implement, setup and configure a realistic enterprise computing application and its environment. Candidates who select the Master's Project must choose a major professor to direct their project. The advisor and the student may identify other resource persons to serve in an advisory capacity for the project. Before beginning the project, student must present a project concept proposal to the major professor. The Director of Graduate Studies must approve this project. Student will write a project report and present the study at an announced open forum similar to the thesis defense. This report will not be on file in the Howard University library.</p>		
CSCI-699	Master's Thesis	3 Credits
<p>The thesis option provides the student the opportunity to conduct original research and to report this in a scholarly manuscript. This option is especially well suited to a student who plans on pursuing a PhD degree. Students who select this option must choose a major professor to act as the chair of their thesis committee and two additional committee members. Before beginning work on a thesis, a student must present a proposal to their committee for approval. The committee will direct and supervise the work carried out by the student. The student is bound by the Graduate School rules and regulations for thesis defense.</p>		

Financial Support in the Department

Financial support in the Department of Computer Science is available in three forms:

1. **University Graduate Assistantships.** These positions carry a remission of tuition and the requirement that the student work 20 hours a week as a Teaching Assistant under the direction of the department, usually in support of department classes in beginning programming courses. These are often awarded very early in the application cycle. As a matter of policy, all entering graduate students are considered for such funding unless they state otherwise. A letter of interest addressed to the department chair, resume, and transcript are all that is required for consideration. Selection criteria include: undergraduate major, GPA, relevant work experience and communications skills.
2. **Research Assistantships.** These are funded by faculty research grants, which are almost always based on funds the faculty member has obtained to support his or her area of research. These are often awarded at different times in the application cycle, since grants are awarded at different times. The funds also expire at different times during the academic year, depending on the particular grant or contract. As a matter of policy, all entering graduate students are considered for such funding unless they state otherwise. A letter of interest addressed to the department chair, resume, and transcript are all that is required for consideration. Selection criteria include: undergraduate major, GPA, relevant work experience and communications skills.
3. **Graduate School funded support.** These funds are almost always handled entirely by the Graduate School. For more information on these funds, visit the graduate school website at www.gs.howard.edu.

Departmental Honor Code Policy for Programming Projects

Unless otherwise stated, at the time that an assignment or project is given, all work handed in for credit is to be the result of individual effort. (In some classes group work is encouraged; if so, that will be made explicit when the assignment is given.)

I. You (or your group, if a group assignment) may:

- seek assistance in learning to use the computing facilities;
- seek assistance in learning to use special features of a programming language's implementation;
- seek assistance in determining the syntactic correctness of a particular programming language statement or construct;
- seek an explanation of a particular syntactic error;
- seek explanations of compilation or run-time error messages

II. You (or your group, if a group assignment) may not seek assistance from anyone else, other than your instructor or teaching assistant:

- in designing the data structures used in your solution to a problem;
- in designing the algorithm to solve a problem;
- in modifying the design of an algorithm determined to be faulty;
- in implementing your algorithm in a programming language;
- in correcting a faulty implementation of your algorithm
- in determining the semantic correctness of your algorithm.

III. Unless permission to do so is granted by the instructor, you (or your group, if a group assignment) may not:

- give a copy of your work in any form to another student;
- receive a copy of someone else's work in any form;
- attempt to gain access to any files other than your own or those authorized by the instructor or computer center;
- inspect or retain in your possession another student's work, whether it was given to you by another student, it was found after other student has discarded his/her work, or it accidentally came into your possession;
- in any way collaborate with someone else in the design or implementation or logical revision of an algorithm;
- present as your own, any algorithmic procedure which is not of your own or of the instructor's design, or which is not part of the course's required reading (if you modify any procedure which is presented in the course's texts but which is not specifically mentioned in class or covered in reading assignments, then a citation with page number must be given);
- incorporate code written by others (such as can be found on the Internet);

IV. You must:

- report any violations of II and III that you become aware of;
- if part of a group assignment, be an equal "partner" in your group's activities and productions, and represent accurately the level of your participation in your group's activities and productions.

ADMISSIONS INFORMATION

The University promotes academic excellence through a highly selective admission process. Students who are admitted show strong personal motivation along with backgrounds of consistent academic growth and achievement. The University also attracts and seeks out socially and economically deprived students who show promise of gaining from a Howard University education.

To protect its character and standards of scholarship, the University reserves the right, and the applicant concedes to the University the right, to deny admission to any student at any time for any reason the University deems sufficient.

Note to Prospective Students

On September 24, 1983, the Board of Trustees of Howard University adopted the following policy statement regarding applicants for admission: "Applicants seeking admission to Howard University are required to submit accurate and complete credentials and accurate and complete information requested by the University. Applicants who fail to do so shall be denied admission. Enrolled students, who as applicants failed to submit accurate and complete credentials or accurate and complete information on their application for admission shall be subject to dismissal when the same is made known regardless of classification."

Any applicant with an acceptable academic record and an undergraduate degree from a regionally accredited institution or any international student with equivalent qualifications is eligible to apply for admission to the Graduate School. Applicants are expected to have received adequate training in the fields in which graduate work is planned. The department in which the student plans to study shall determine whether or not the student's training is adequate. If a student is qualified to be admitted for graduate study in a particular graduate department, a recommendation for admission is made to the Graduate School by the department. Special admission criteria for the individual departments are included in the descriptions of the programs offered through the Graduate School.

A cumulative grade point average of 3.0 on a 4.0 scale is required, and a cumulative grade point average of 3.0 in major course work is required.

General Admission Requirements

- On-line application and signature page or
- Downloadable paper application (HTML) | (Acrobat). Please refer to the code sheet.
- The non-refundable \$45 application fee (check or money order ONLY)
- Official transcripts must be submitted directly from the Registrar's Office from ALL colleges and universities attended (exceptions require the approval of the Dean)
- GRE Scores (Only official score reports are accepted within 5 years of the test date) www.gre.org GRE scores sent directly from ETS (HU code: 5297)
- Statement of Academic and Research Interest
- Autobiographical Sketch (Personal biography)
- Resume
- Three letters of recommendation sent directly to the Office of Graduate Recruitment and Admissions in a sealed envelope Word (MUST BE IN SEALED ENVELOPES)

International Applicants Admission Requirements

In addition to the requirements listed above you must submit the following:

- Official transcripts, final certificates and/or mark/grade sheets must be sent directly from the college or university to the Office of Graduate Recruitment and Admissions, and must show proof of degree(s) earned, courses taken and marks/grades received. In situations where the university will not send transcripts directly official transcripts, received indirectly, can be approved by the Dean's Office. Also, ALL transcripts must be evaluated by World Education Services (www.wes.org) or AACRAO (www.aacrao.org) and be forwarded to Graduate Recruitment and Admissions.
- If the transcripts are not in English, they must be accompanied by an official translated copy.
- All documents must bear the same name that appears on the admissions application unless an official document so submitted indicating a change of name.
- TOEFL Scores (Minimum computer-based score of 213 is required and only official score reports are accepted within 2 years of the test date) www.toefl.org. TOEFL scores must be sent directly from ETS (HU code: 5297).
- The TOEFL test is not required if you received a degree in the U.S.
- Statement of Financial Resources – A completed form that verifies proof of financial support (sufficient funds to cover expenses for one full year – as indicated on the graduate school website) and supporting financial documentation indicating sources of funds while attending Howard University (such as a certified bank statement dated within three months of registration).
- Verification of six months history with bank.

For information on how to apply and where to send materials for other graduate and professional programs at Howard University, visit the Graduate School webpage - www.gs.howard.edu

Caution to Prospective Students

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Application Deadlines

- **Fall Semester:** February 15th**
- **Spring Semester:** October 1st
- **Summer Semester:** March 15th

All credentials must be sent to:

Howard University Graduate School,
Office of Graduate Recruitment and Admissions
4th and College Streets, N.W., Washington, D.C. 20059

Financial Support Programs:

Merit-based financial support for Graduate Students is available through graduate research and teaching assistantships, fellowships, and tuition scholarships. Each category of support is awarded annually on a competitive basis. Award recipients are expected to perform specific duties for 15 hours per week during the academic year. The responsibilities, often described as an internship, are defined and evaluated by the academic department or the Graduate School depending upon the appointment. The selection / appointment process, eligibility criteria and award package for graduate assistantships, fellowships and tuition scholarships are described below:

Selection and Appointment:

The selection process for each category of financial support is aggressively pursued between February and June for the subsequent academic year. New and continuing graduate students are encouraged to apply early for these awards with the academic chair or director of graduate studies. Additionally, students may apply for financial support administered through the Graduate School. The appointment for graduate assistants and fellows begins on August 15th and ends on May 15th of each academic year. Please note if a funding offer is not presented in writing by June 15 from the academic department or the Graduate School, the likelihood of obtaining one of these awards is greatly diminished. After June 15th, new and continuing students are encouraged to seek external or need-based financial support for the upcoming academic year.

Eligibility:

The minimum GPA requirement is 3.0 for new and 3.2 for continuing students. However, because these awards are merit-based and reviewed competitively, the definition of quality academic performance may vary. Award recipients must enroll for the fall and spring as full-time students defined by a minimum of 9 credit hours. Additionally, students are required to pay their own student fees each semester. ([Click here for Eligibility details](#))

Award Package:

The award package for graduate research / teaching assistantships and fellowships includes a 10-month tuition waiver and a minimum stipend (12,000 for master's students and 13,000 for Ph.D. students). In many cases, additional stipend support is available through funded grants. Students may inquire about these opportunities at the time of application submission.

Stipend Disbursement:

Graduate research / teaching assistants and fellows should prepare to receive their stipend disbursement the first payroll date in September. The last disbursement occurs the final pay cycle in May. Please note new international graduate students typically receive the first stipend disbursement during the last pay cycle in September due to the process of obtaining a social security number. However, the first stipend amount will be greater to reflect the appointment date.

The Financial Aid Office is located in the Johnson Administration Building (Main Campus) Room 205, 2400 Sixth Street, N.W., Washington, DC 20059. Hours of operation are 8:30 a.m. - 3:00 p.m. Monday, Tuesday, Thursday and Friday. The office is open from 8:30 – 5:00 on Wednesdays.

<http://www.howard.edu/financialaid/>

Applications for financial support administered by the Graduate School should be mailed to:

Office of Retention, Mentoring and Support Programs
Howard University Graduate School
4th and College Streets, NW, Washington, DC 20059
ATTN: Fellowship Committee

GETTING REGISTERED

It is extremely important that you see your academic advisor prior to registering to ensure that you select the appropriate courses, complete a Request for Registration form, and get a personal identification number (PIN). Our current registration system is designed to prohibit students from registering for classes for which they have not completed the required pre- or co-requisite courses. Therefore, if you encounter a "registration error," this means that the system does not recognize you as having met the prerequisite(s) for the selected course. You must make another selection, or meet with your advisor for a course prerequisite override. If your advisor feels that you have met the prerequisite(s) for a particular course, he/she will approve your course selection.

1. Read over these instructions, or print them out. Once you are finished, go to the bottom of this page and click "Proceed to Bison Web Registration and Students Service".
2. Click LOG IN TO SECURE AREA on the Bison Web homepage.
3. Enter the "@" sign followed by your student identification number. Then enter your PIN. Your PIN must be six (6) numerical digits. Click the "LOGIN" button.

For information on your PIN number, please use one of the following resources:

- o Student Reference Manual (page 11)
 - o Your advisor
 - o Enrollment Management (202-806-2705)
 - o Courtesy desk in the Blackburn Center Ballroom
4. Type in your PIN again on the Login Verification Page, and click the LOGIN button.
 5. If this is the first time you have signed on, a TERMS OF USAGE PAGE will display. Please read and if you accept the terms, click the CONTINUE button. If you do not accept the terms, click the EXIT button.
 6. Select the phrase Student Services and Financial Aid.
 7. Select the phrase Registration.

8. When the REGISTRATION page displays, click on SELECT TERM.
9. When the SELECT TERM page displays, click on the arrow at the right of the word TERM and select the appropriate term.
10. Click on the SUBMIT TERM button. The system will return you to the REGISTRATION page.
11. Click on CHECK YOUR REGISTRATION STATUS to assure you are able to register. If there are no holds which prevent registration click on the MENU at the top right of the page. If you are not able to register click the exit button at the top of the page.
12. When the registration page displays click on LOOK UP CLASSES TO ADD and follow the instructions.
13. When the classes are displayed, select the courses you want by clicking the boxes on the left side of the courses. When all courses are selected, click the REGISTER button. If there are no errors, you are now registered. If there are errors, you must restart from step 11.

This completes the registration process. Please verify your course selections by printing your schedule and making sure that the appropriate grade mode has been selected. If you need further assistance, call 806-2705.

STAFF

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CONTACT US

General Department Information

Phone: (202) 806-6595
 FAX: (202) 806-4531
 Web: <http://www.cs.ceacs.howard.edu/>

Advising Information: www.cs.ceacs.howard.edu/scs_advising

Surface Mail:

Department of Computer Science
 College of Engineering, Architecture and Computer Sciences
 Howard University
 Room 2120 Downing Hall
 2300 Sixth Street NW
 Washington, DC 20059

Graduate Admissions and Graduate Studies

Phone: (202) 806-6800 FAX: (202) 462-4053 Web: <http://www.gs.howard.edu/>