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## COMPUTER SCIENCE (Ph.D.)

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*Executive Officer:* Professor Ted Brown

The Graduate Center

365 Fifth Avenue

New York, NY 10016

Email: [Compsci@gc.cuny.edu](mailto:Compsci@gc.cuny.edu)

URL: <http://www.cs.gc.cuny.edu>

### FACULTY (AS OF JULY 2009)

Michael Anshel n David Arnow n Sergei Artemov n Spiridon Bakiras n Amotz Bar-Noy n Gilbert Baumslag n Raquel Benbunan-Fich n Octavio Betancourt n Gary Bloom n Kent D. Boklan n Peter Brass n Peter Brinkman n Theodore Brown n Candido Cabo n Jinlin Chen n Weifeng Chen n Samir Chopra n James L. Cox n Louis A. D'Alotto n Scott David Dexter n Bernard Domanski n Susan Epstein n Ahmet M. Eskicioglu n Xien Fan n Nelly Fazio n Melvin Fitting n Linda Weiser Friedman n Konstantinos Georgatos n Izidor Gertner n Irina Gladkova n Robert Goldberg n Nancy D. Griffeth n Ari David Gross n Michael D. Grossberg n Natacha T. Gueorguieva n Olympia Hadjiliadis n Joel D. Hamkins n Robert M. Haralick n Keith Harrow n Gabor T. Herman n Richard D. Holowczak n Matt Huenerfauth n Yumei Huo n S. Imberman n Yves Daryl Jean n Heng Ji n Ping Ji n Gwang S. Jung n Delaram Kahrobaei n Akira Kawaguchi n Bilal Khan n Jinwoo Kim n Tat Yung Kong n Wolf Kohn n Danny Kopec n Michael E. Kress n Saul Kripke n Kui-Lam Kwok n Myung Jong Lee n Florian Lengyel n Xiangdong Li n Attila Máté n Russell G. Miller n Saad Mneimneh n Abbe Mowshowitz n Constantin Virgil Negoita n Bojana Obrenic n János Pach n Victor Pan n Rohit Parikh n Simon D. Parsons n Louis Petingi n Ihsin Tsaiyun Phillips n Frank Leon Pritchard n Theodore Raphan n Kaliappa Ravindran n Boojala Reddy n Ira Rudowsky n Alexander J. Ryba n William G. Sakas n Lori L. Scarlatos n Subash Shankar n William E. Skeith III n Elizabeth Sklar n Dina Sokol n Katherine St. John n Ioannis Stamos n Bon K. Sy n Isak Taksa n Abdullah Uz Tansel n Miriam Tausner n Virginia Teller n Aaron Tenenbaum n Ying-Li Tian n Douglas R. Troeger n M. Ümit Uyar n Felisa J. Vázquez-Abad n Dinesh C. Verma n Hoeteck Wee n Jie Wei n Stewart N. Weiss n Jennifer Whitehead n Paula Whitlock n George Wolberg n Zhigang Xiang n John (Jizhong) Xiao n Noson S. Yanofsky n Gabriel Yarmish n Stathis K. Zachos n Christina M. Zamfirescu n Sarah Zelikovitz n Danyang (Dan) Zhang n Jianting Zhang n Shuqun Zhang n Xiaowen Zhang n Zhanyang Zhang n Jun Zheng n Neng-fa Zhou n Zhigang Zhu

*For the most up-to-date faculty listings and specializations, see the program's Web site.*

### THE PROGRAM

The Ph.D. Program in Computer Science is designed to prepare selected students for leadership in industrial careers and research as well as in teaching and academic research. The ubiq-

uitous role of the computer in our society requires that the Ph.D. candidate master the discipline of computer science in its broadest sense as well as display knowledge of a specialized area and perform independent research.

### ***Areas of Study***

The program is particularly strong in the following specializations. (Please note that the division into areas of study is somewhat artificial; some courses are relevant to more than one area or, depending on the instructor's focus, could be placed in another area.)

### ***Programming Languages and Software Methodologies***

Programming language development has been an active area of research in computer science almost from the origin of computer science itself. Nowadays, programming languages are defined formally. Stylistically, a programming language can be classified either as an imperative language or as a declarative language. Programs written by a user in a particular programming language should make use of computer software development methodologies. These methodologies not only foster good or correct practice in writing a program, but include techniques that cover the range of phased activities that a software product goes through from its conception through implementation to its maintenance. "Software Engineering" techniques are included in this category. Current faculty interests include formal methods of program description, verifying program correctness, declarative language construction, and mathematical linguistics.

### ***Theoretical Computer Science and Its Applications***

Predating the field of computer science, theoretical computer science is a mathematically rigorous study of computing. It includes a theory of computing machines, solvability, formal language theory, and concepts of timing. The area is so basic that it is often called "foundations." Topics include formal languages, automata theory, computability and unsolvability, and logic of programs]. Current faculty interests include computational geometry, security, recursion theory, applied logic, and computational complexity.

### ***Artificial Intelligence, Cognitive Science, and Adaptive Systems***

Artificial intelligence (AI) and cognitive science are concerned with developing algorithmic methodologies that can mimic various aspects of human performance and their implementation as computer programs. These methodologies include symbolic knowledge representation, concepts and methods of inference, modeling human thought and sensory-motor performance. Cognitive science includes developing methodologies that model neural systems and adaptive dynamical systems. Current faculty interests include computational linguistics, data mining, natural language processing, learning and understanding systems, human locomotion and balance control, neural networks, logic in artificial intelligence, including logic programming, knowledge and belief, and image recognition systems.

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### *Scientific Computing and Modeling of Systems*

The original impetus for the creation of a computing machine was the need to do large-scale numerical computations. The field of numerical computation techniques continues to grow, with numerical calculations still playing an important role in scientific research. New approaches and techniques evolve that are quite general and powerful. Simulation of systems likewise plays an important role in scientific inquiry and more broadly in the design of all systems (including computer systems). Analytic modeling is another tool useful for analyzing the behavior of designed but not yet implemented systems. Current faculty interests include simulation of continuous and discrete systems, statistical modeling of systems, numerical algebra, numerical analysis, and biomedical computing.

### *Algorithms and Their Analysis*

Algorithm design is at the heart of computing. Algorithms are the detailed procedures that in a finite number of steps accomplish a computing task. Thus this is a broadly defined category that impinges on all other areas. Current faculty interests include cryptography, combinatorial algorithm design, run time complexity, parallel and distributed algorithm design, and analysis of algorithms.

### *Computer Architecture, Networks, and Communications Systems*

With the dynamic development of computer technology, hardware and computer architecture are important areas of research and development. The courses offered in this area include advanced computer architecture and computer/network communications. Current faculty research includes computer networks, parallel computation, neural nets, petri nets, and telecommunications.

### *Media Processing, Computer Vision, and Graphics*

The design, distribution, display, recognition, storage schemes, large data sets, and multiple media in a document are important applied research areas in computer science. Medical information processing is a closely aligned research area. It teams physicians and computer scientists and has the potential of producing significant health-related goals. CUNY has a number of faculty members interested in this area. Current interests include graphics, computer vision, document understanding, database technology and document storage and retrieval, medical information processing, digital topological techniques for image processing, real-time processing of biomedical signals, and multiresolution approaches for image understanding.

Courses in the Ph.D. Program in Computer Science are offered at the Graduate Center as well as at Baruch College, Brooklyn College, The City College, Queens College, and The College of Staten Island.

## **SPECIAL REQUIREMENTS FOR ADMISSION**

In addition to the University's requirements for admission stipulated earlier in this bulletin, the applicant is expected to have attained a minimum average of B in his/her undergraduate major and to have completed course work equivalent to an undergraduate major in computer science. Exceptions will be considered by the program's Admissions Committee for those applicants

with an undergraduate major in one of the fields cognate to computer science or with extensive experience in the field.

Specifically, entering students are expected to have a background (minimally, at an undergraduate level) in the following areas: Operating Systems; Fundamental Algorithms; Object-Oriented Programming (e.g., C++ or Java); Databases; Discrete Mathematics; Computer Networks; Theoretical Computer Science (Logic, Models of Computation, Analysis of Algorithms); Programming Languages; and Probability.

Students who are admitted with deficiencies in their background will be required to take graduate (or undergraduate) courses to make up for them prior to attempting the core courses. Courses that are required to fulfill deficiencies can be included in the first 30 credits of the degree if they are approved, if they are graduate courses, and if the student achieves at least a B grade in the course.

### **SPECIAL REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY**

The following requirements are in addition to the University requirements for the Ph.D. as stated earlier in this bulletin.

*Program of Study* The curriculum for all doctoral students in the Ph.D. Program in Computer Science consists of a minimum of 60 graduate credits beyond the baccalaureate degree, in addition to undergraduate deficiencies that may have to be remedied. Transfer credits will be subject to the rules pertaining to CUNY doctoral students.

The following core courses are required of all entering matriculants.

C SC 70010 Algorithms

C SC 75010 Theoretical Computer Science

C SC 71010 Programming Languages and their Implementation

C SC 72010 Computer Networks

C SC 74010 Logical Foundations of Computer Science

C SC 79100 Seminar: Research at CUNY

These six courses are offered during a matriculant's first year in the program, after which the student is required to sit for, and pass, the First Examination.

The First Examination is based on the first five courses listed above (excluding 79100).

Other course requirements: Upon completion of the First Examination, but before being advanced to candidacy, students are required to complete one of the following: C SC 80000, C SC 83005, C SC 82005, C SC 85011, C SC 85031, or C SC 86005, at least four 800-level courses, in at least two areas of specialization, plus one of the program's seminar courses: C SC 80200, 81200, 82200, 83200, 84200, 85200, 86200, or 87200. The remaining courses will be selected mainly from those in the area of specialization and research interests of the students, under the supervision of a faculty adviser or advisory committee. The advisory committee will consist of the student's faculty adviser and other members of the doctoral faculty whose areas of specialization are considered to be directly relevant to the student's intended dissertation research topic.

*First Examination* Students shall take the First Examination at the first sitting following their completion of the core courses. Students failing the First Examination must retake the examination within one year. Students not passing their second attempt of the examination

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will not be allowed to continue in the Ph.D. program. It is recommended that students not passing their first sitting of this exam audit the core course(s) upon which the exam is based. A student must successfully complete this requirement before attaining 45 credits of approved course work.

*Second Examination* After successful completion of the program's First Examination requirement and completion of all required course work, the candidate must pass a two-part Second Examination. The Second Examination examines the student's in-depth knowledge and understanding of the area of computer science directly related to his/her topic of intended research. The Second Examination should be completed within two years of the completion of the First Examination. This Examination has both a written and oral component.

*Research Tool* Before advancing to candidacy, a student is required to show high-level programming proficiency. Students will satisfy this requirement by submitting to the Executive Officer a large computer program, written by themselves. The program must include relevant documentation. This program can be one written in industry, one developed on his/her own, or one developed as part of a course that requires the writing of a large program.

*Dissertation Proposal* Within two years of having advanced to Candidacy, a student is expected to defend his/her dissertation proposal, which outlines the particular research project the student plans to undertake. This examination has a written and oral part.

*Dissertation* The student is required to complete a dissertation based on original research in one of the areas of specialization under the guidance of his/her faculty adviser and advisory committee. After the dissertation has been approved by the faculty adviser and Examination committee, the student must successfully defend it in an oral examination to which all doctoral students and faculty will be invited. The Examination Committee must include one invited scholar from outside the City University who is considered a subject matter expert in the field of the thesis.

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## Courses

All courses are 3 credits, except as noted. Please note that some courses may be offered infrequently; consult with the program for further information.

### *Algorithms and Their Analysis*

- C SC 70010 Algorithms
  - C SC 80010 Algorithms for Parallel and Distributed Computation
  - C SC 80020 Topics in Combinatorial Algorithms
  - C SC 80030 Topics in Algorithm Design
  - C SC 80040 Topics in Algorithm Analysis
  - C SC 80200 Seminar in Algorithm Design and Analysis
- 1 credit

### *Programming Languages and Software Methodologies*

- C SC 71010 Programming Languages
- C SC 81010 Topics in Theoretical Underpinnings of Programming Language Design

- C SC 81020 Topics in Computer Software Development
- C SC 81030 Topics in Programming Languages
- C SC 81040 Topics in Databases
- C SC 81200 Seminar in Software Design

*1 credit*

***Computer Architecture, Networks, and Communications Systems***

- C SC 72010 Computer Networks
- C SC 82005 Advanced Computer Networks
- C SC 82010 Computer Systems
- C SC 82020 Computer Communication Systems
- C SC 82100 Advanced Topics in Computer Systems
- C SC 82110 Advanced Topics in Operating Systems
- C SC 82200 Seminar in Computer Systems

*1 credit*

***Media Processing, Computer Vision, and Graphics***

- C Sc 83005 Computer Vision
- C SC 83010 Topics in Computer Graphics
- C SC 83020 Topics in Computer Vision
- C SC 83030 Topics in Information Retrieval
- C SC 83040 Topics in Document Analysis
- C SC 83050 Topics in Image Processing
- C SC 83060 Topics in Media Processing
- C SC 83200 Seminar in Media Processing, Computer Vision or Graphics

*1 credit*

***Artificial Intelligence, Cognitive Science, and Adaptive Systems***

- C SC 74010 Logical Foundations of Computer Science
- C SC 84010 Topics in Artificial Intelligence
- C SC 84020 Topics in Adaptive Systems
- C SC 84030 Computational Models of Cognitive Systems
- C SC 84200 Seminar in Artificial Intelligence and Cognitive Science

*1 credit*

***Theoretical Computer Science and Its Applications***

- C SC 75010 Theoretical Computer Science
- C SC 85010 Topics in Logics and their uses
- C Sc 85011 Logic in Computer Science
- C SC 85020 Topics in Theoretical Computer Science
- C SC 85030 Topics in Cryptography and Computer Security
- C SC 85031 Discrete Mathematics for Cryptographic Applications
- C SC 85040 Topics in Computational Complexity

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C SC 85200 Seminar in Theoretical Computer Science

*1 credit*

***Scientific Computing and Modeling of Systems***

C SC 86005 Statistical Techniques and Probability Models in Computer Science

C SC 86010 Scientific Computing and Numerical Methods

C SC 86020 Probabilistic Modeling of Computer Systems

C SC 86030 Topics in Simulation Methodology

C SC 86200 Seminar in Scientific Computing

*1 credit*

C SC 86210 Seminar in Modeling Computer Systems

*1 credit*

***Miscellaneous***

C SC 79000 Independent Study/Research Project

C SC 79100 Seminar: Research at CUNY

*1 credit*

C SC 80000 Readings in Computer Science

C SC 87100 Selected Topics in Computer Science

C SC 87200 Seminar General Topics

C SC 89000 Doctoral Dissertation Research

*1 to 6 credits*

C SC 90000 Dissertation Supervision

*1 credit*