
Computational Science and Engineering M.S. Program

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OBJECTIVES

The program is designed with the following objectives:

1. To educate graduate students with a mastery of high performance computer programming tools as well as processing, data acquisition, and analysis techniques.
2. To educate and train students in computational modeling, simulation and visualization.
3. To assist students to relate acquired computational science and engineering knowledge and skills to specific application fields of engineering, science, technology and business.
4. To teach students to develop novel and robust computational methods and tools to solve scientific, engineering, and technological and business problems.
5. To produce highly versatile computational scientists, engineers, technologists, or business executives with a good understanding of the connections among various disciplines, capable of interacting and collaborating effectively with scientists, engineers, and professionals in other fields.
6. To increase the number of graduate professionals available to work in computational science and engineering.
7. To increase the diversity of graduate professionals, especially underrepresented minority and African Americans available to work in the computational science and engineering field.
8. To assist the State of North Carolina and the nation to increase the pool of graduates with training and experience in computational science and engineering, interdisciplinary applications and research.

GENERAL PROGRAM ADMISSION REQUIREMENTS

Candidates seeking admission to the Computational Science and Engineering (CSE) Program for the Master of Science degree must meet the following requirements:

1. Computational Science and Engineering track: Bachelor's degree in engineering, physics, computer science, or mathematics from an accredited program.
2. Computational Science track: Bachelor's degree in Chemistry, Biology, Business and Agricultural Sciences.
3. Computational Technology track: Bachelor's degree in Technology or related field.
4. Official TOEFL scores of at least 550 or better (213 computer-based score) for students whose native language is other than English. In addition all international students are required to submit official GRE scores. Scores should be submitted directly to the School of Graduate Studies.
5. General prerequisites: (1) Calculus through differential equations for the computational science and engineering track, (2) college chemistry and physics, (3) college math (4) elementary numerical analysis or one semester of linear algebra for the computational science and engineering track. These are in addition to the courses in the student's principal undergraduate bachelor degree discipline. Programming and working knowledge of at least one high level programming language such as FORTRAN, C++, or Java is also required for the computational science and engineering track, and recommended for other tracks depending on the student's area of interest. There may also be additional recommended or required prerequisites specific to the needs of a focus area.

Documentation Requirements

The following documents are to be submitted by all applicants.

1. Two official transcripts of all college-level academic work.
2. Three letters of recommendation (for study at the graduate level) from professional associates or supervising faculty/professors from the degree granting institution.
3. An official copy of the TOEFL score, if applicable, mailed directly to the University from the testing agency.
4. The completed application form and application fee stipulated by the School of Graduate Studies at NC A&T State University.
5. A “Statement of Purpose” in the context of pursuing the M.S. degree in Computational Science and Engineering.

Computational Science and Engineering Tracks

Computational Science and Engineering

This track is designed primarily for students with undergraduate degrees in engineering, physics, mathematics, and computer science who will be trained to develop problem-solving methodologies and computational tools as well as interdisciplinary technical expertise in CSE for solving challenging problems in physical science, engineering, applied mathematics or computer science. This includes domains that are both in the College of Engineering, and the College of Arts and Sciences. The curriculum will emphasize computational sciences and engineering along with training in the domain areas. The goal of this track is to produce scientists and engineers with focus, training and application in computational sciences, scalable computing, physics-based modeling and simulations, and with expertise in the application of computational techniques and principles in their primary domain areas. Qualified undergraduate students can be admitted to this stream if they also meet the admission criteria of their major domain field. Based on their undergraduate degrees, the students in this track would be required to have had an increased level of prior training, courses and exposure to mathematics, including areas such as numerical analysis, and high level programming languages. Students with undergraduate degrees in other science and technology areas may also be admitted, if they meet the admission and course requirements, including prerequisites of the domain department. The areas of specialization will include, but will not be limited to, computational quantum chemistry, computational nuclear and high energy physics, computational solid or fluid dynamics, computational material science, bioengineering, engineering design and automation, applied and environmental geophysics, computational seismology, nonlinear computational mechanics, super fast algorithms for numerical and algebraic computation, and distributed and high performance computing.

Computational Sciences

This track is designed primarily for students with undergraduate degrees in chemistry, biology, business, and agricultural sciences who will be trained to apply or extend computational tools and methods as well as data acquisition, processing and visualization techniques to study computationally intensive problems in life sciences, agricultural and environmental sciences, and business and economics. This track primarily includes domain areas with lesser training in mathematics including numerical analysis, and programming languages and focuses on domains with non-deterministic models. The domains in this track are for the College of Arts and Sciences, the School of Agriculture and Environmental Sciences and the School of Business and Economics. The goal of this track is to produce biological and life scientists, business professionals and economists, and agricultural scientists with focus and expertise in computational sciences and the primary domain areas. Qualified undergraduate students can be admitted to this stream if they also meet the admission criteria of the major domain area. Based on their undergraduate field, the students in this track would be required to take additional mathematics and programming focused courses. Students with undergraduate degrees in other science, engineering and technology areas may also be admitted if they meet the admission and course requirements, including prerequisites for the domain department. The areas of specialization will include, but will not be limited to, bioinformatics, computational genomics, computational physical chemistry, computational biochemistry, and computational finance.

Computational Technology

This track is designed primarily for students with undergraduate degrees in technology disciplines with a focus on computational science and engineering. These technology disciplines currently include computation technology, computer numerical control machining, remote sensing, GIS/GPS data analysis, and nanotechnology with additional potential disciplines in the future. The goal of this track is to produce technologists with a focus and training in computational sciences, and in their primary technology domain area. Students with undergraduate degrees in

engineering, mathematics, physics and computer science may also be admitted and must meet the course and curriculum requirements in technology.

PROGRAM OPTIONS AND DEGREE REQUIREMENTS

The program requires 34 credit hours at the graduate level beyond the undergraduate degree distributed as follows:

Thesis Option:

27 credit hours for course work at the graduate level,
 1 credit hour for seminars, and
 6 credit hours for thesis research.

Project Option:

30 credit hours for course work at the graduate level,
 1 credit hour for seminars, and
 3 credit hours for graduate masters project.

	Year One
<i>Fall Semester</i>	
CSE 701 - Applied Probability and Statistics	3cr
CSE 702 - Comprehensive Numerical Analysis	3cr
Domain course I	3cr
<i>Spring Semester</i>	
CSE 703 - Data Structures, Software Principles and Programming in Scalable Parallel Computing.	3cr
CSE 704 - Computational Modeling and Visualization	3cr
Domain course II	3cr
Year Two	
<i>Fall Semester</i>	
Interdisciplinary course I	3cr
Interdisciplinary course II	3cr
Interdisciplinary course III	3cr (for project option)
Thesis	3cr (for thesis option)
Seminar	1cr
<i>Spring Semester</i>	
Domain course III	3cr
Thesis	3cr (for thesis option)
Master's Project	3cr (for project option)

All students irrespective of the track that they are registered in must successfully complete the core courses CSE-701, CSE-702, CSE-703 and CSE-704.

All students must complete the Graduate Seminar course CSE 792, which accounts for 1 credit hour.

Students pursuing the thesis option must complete 6 credits hours of CSE 797.

Students pursuing the project option must complete 3 credits hours of CSE 796.

A partial list of Domain courses and Interdisciplinary courses from which a student can choose based on the track the student is registered in is as follows;

Computational Science and Engineering Track

Domain Courses:

Mechanical Engineering: MEEN 655, MEEN 716, MEEN 719, MEEN 822, MEEN 846, MEEN 847, MEEN 849

Civil Engineering: CIEN 600, CIEN 614, CIEN 668, CIEN 644, CIEN 660, CIEN 662, CIEN 664, CIEN 700, CIEN 702, CIEN 736, CIEN 737, CIEN 754

Industrial Engineering: INEN 615, INEN 624, INEN 665, INEN 721, INEN 742, INEN 745, INEN 813, INEN 814, INEN 822, INEN 841, INEN 843, INEN 844, INEN 853

Computer Science: COMP 653, COMP 662, COMP 670, COMP 732, COMP 733, COMP 747, COMP 753, COMP 755, COMP 770, COMP 785

Electrical Engineering: ELEN 656, ELEN 674, ELEN 678, ELEN 749, ELEN 762, ELEN 764, ELEN 821, ELEN 857, ELEN 862, ELEN 865, ELEN 867, ELEN 870, ELEN 871

Chemical Engineering: CHEN 630, CHEN 620, CHEN 640, CHEN 710, CHEN 720, CHEN 730, CHEN 740, CHEN 760

Physics: PHYS 605, PHYS 630, PHYS 744, PHYS 745

Mathematics: MATH 608, MATH 624, MATH 631, MATH 652, MATH 706, MATH 708, MATH 712, MATH 721, MATH 723, MATH 731, MATH 781, MATH 782

Interdisciplinary Elective Courses:

PHYS 745, PHYS 746, BIOL 705, BIOL 706, MEEN 655, MEEN 716, PHYS 791, MATH 791, CSE 711, CSE 712, CSE 713 or any other qualifying domain courses that are not from the major domain area of the student. Students registered for the thesis option must complete 6 credit hours of course work from this list and students registered for the project option must complete 9 credit hours of course work from this list.

Computational Science Track

Domain Courses:

Chemistry: CHEM 674, CHEM 731, CHEM 732, CHEM 741, CHEM 742, CHEM 743, CHEM 749, CHEM 735, CHEM 755

Agribusiness and Science: AGECE 638, AGECE 675, AGECE 705, AGECE 708, AGECE 710, AGECE 720, AGECE 740, AGECE 756

Animal Sciences: ANSC 637, ANSC 665, ANSC 771, ANSC 782

Human Environment and Family Sciences: HEFS 653

Natural Resources and Environmental Design: SLSC 632, NARS 610, AGRI 604

Biology: BIOL 630, BIOL 640, BIOL 642, BIOL 665, BIOL 700, BIOL 703, BIOL 704

Business and Economics : BUAD 715, BUAD 713, ECON 706, ACCT 708, ACCT 714, BUAD 730, BUAD 731, BUAD 732, BUAD 733, BUAD 734, BUAD 735, BUAD 736, TRAN 701, TRAN 720, TRAN 725, TRAN 727, TRAN 730

Interdisciplinary Elective Courses:

PHYS 745, PHYS 746, BIOL 705, BIOL 706, MEEN 655, MEEN 716, PHYS 791, MATH 791, CSE 711, CSE 712, CSE 713 or any other qualifying domain courses that are not from the major domain area of the student. Students registered for the thesis option must complete 6 credit hours of course work from this list and students registered for the project option must complete 9 credit hours of course work from this list.

Computational Technology

Domain Courses:

Construction Management and Occupational Safety and Health: MSIT 610, MSIT 779,

Electronics and Computer Technology and Manufacturing Systems: ECT 600, ITT 634, ECT 635, ITT 650, ITT 629, ITT 630, ITT 665, ITT 670, ITT 680, CUIIN 760, CUIIN 761,

Graphics Communication Systems: GCS 631, GCS 632,

Manufacturing Systems: MFG 651, MFG 674, MFG 696, MFG 760

Interdisciplinary Elective Courses:

PHYS 745, PHYS 746, BIOL 705, BIOL 706, MEEN 655, MEEN 716, PHYS 791, MATH 791, CSE 711, CSE 712, CSE 713 or any other qualifying domain courses that are not from the major domain area of the student. Students registered for the thesis option must complete 6 credit hours of course work from this list and students registered for the project option must complete 9 credit hours of course work from this list.

ADVISORY COMMITTEE AND PLAN OF GRADUATE WORK

Initially the Director of the program will serve as the academic advisor for all new students entering the program. Each student in the M.S. program is expected to select a major advisor by the beginning of the second semester with the approval of the Director. The major advisor must hold a tenure or tenure-track full-time faculty position at the university. However, a co-advisor may have non-tenure-track/adjunct status.

The M.S. Advisory Committee will consist of a minimum of three (3) graduate faculty members with the major advisor as its chairperson. Committee members must be from at least two different departments. Members could represent

more than one campus School/College. The M.S. Advisory Committee will be recommended by the major advisor with input from the student to the Director of the CSE program for approval by the Dean of Graduate Studies.

OTHER INFORMATION

See “Requirements for the Master of Science Degree” elsewhere in this catalog for information related to residence requirements, qualifying examination, preliminary examination, final oral examination, admission to candidacy, and time limit. Additional details of requirements for the program are outlined in the Computational Science and Engineering M.S. Program Student Handbook available from the Graduate School.

List of Courses	Credits
CSE 701 Applied Probability and Statistics	3
CSE 702 Comprehensive Numerical Analysis	3
CSE 703 Data Structures, Software Principles and Programming in Scalable Parallel Computing	3
CSE 704 Computational Modeling and Visualization	3
CSE 711 Nano-Scale Science and Engineering	3
CSE 712 Nano-Scale Technology	3
CSE 713 Multi-Scale and Multi-Physics Modeling	3
CSE 785 Special Topics	3

M.S. Level Pass/Fail Courses

CSE 792 Graduate Seminar	1
CSE 793 Master’s Supervised Teaching	3
CSE 794 Master’s Supervised Research	3
CSE 796 Masters Project	3
CSE 797 Masters Thesis	3
CSE 799 Continuation of Masters Thesis	1

COURSE DESCRIPTIONS

CSE 701. Applied Probability and Statistics

Credit 3(3-0)

This course addresses probability and statistics theory and techniques with common application in computational science and engineering. Topics include parameter and distribution estimation, random variables and computer generation, hypothesis testing and confidence intervals, regression analysis, and the design of experiments including analysis of variance.

CSE 702. Comprehensive Numerical Analysis

Credit 3(3-0)

This course provides a comprehensive treatment to numerical methods for the solution of equation systems both in deterministic and non-deterministic problems. Both numerical solution techniques for differential equations, linear systems, data analysis, optimization, regression, Monte Carlo methods, forecast models, etc. will be covered.

CSE 703. Data Structures, Software Principles and Programming in Scalable Parallel Computing

Credit 3(3-0)

This course addresses the concepts, principles hardware and software, communication and computational strategies for scalable, parallel computing systems, the associated computer data structures, programming languages and parallel programming paradigms and associated communications for parallel and scalable computing applications in engineering, sciences, and technology.

CSE 704. Computational Modeling and Visualization

Credit 3(3-0)

This course covers computational techniques for solving deterministic physical models in engineering and sciences, as well as computational techniques for non-deterministic models in business, economics, informatics, statistics, etc. It also involves a detailed study of visualization, analysis and interpretation techniques useful in the analysis of numerical data in both deterministic and non-deterministic disciplines, as well as visualization and interpretation software tools.

CSE 711. Nano-Scale Science and Engineering**Credit 3(3-0)**

This course explores the fundamental understanding and resulting technological advances arising from the exploitation of new physical, chemical, and biological properties of systems that are intermediate in size between isolated atoms and molecules and bulk materials.

CSE 712. Nano-Scale Technology**Credit 3(3-0)**

This course explores the creation and utilization of functional materials, devices, and systems with novel properties and functions that are achieved through the control of matter, atom-by-atom, molecule-by-molecule, or at the macro-molecular level. Nano-scale manufacturing and fabrication requires an entirely new approach: invention of new instruments, measuring tools, models, methods, and standards to characterize nano-scale materials and processes.

CSE 713. Multi-Scale and Multi-Physics Modeling**Credit 3(3-0)**

This course focuses on multi-scale, multi-physics modeling approaches, associated computational techniques involving quantum, atomistic, meso, micro, macro models and the coupling of such models and related applications in engineering, materials and physical sciences.

CSE 785. Special Topics**Credit 3(3-0)**

This course is designed to allow the introduction of potential new courses on a trial basis or special content courses on a once only basis at the Master's level. The topic of the course and title are determined prior to registration. Prerequisite: Consent of Instructor.

CSE 792. Graduate Seminar**Credit 1(1-0)**

Discussions and reports of subjects in Computational Science and Engineering and allied fields will be presented. Prerequisite: Masters level standing.

CSE 793. Master's Supervised Teaching**Credit 3(3-0)**

Students will gain teaching experience under the mentorship of faculty who assist the student in planning for the teaching assignment, observe and provide feedback to the student during the teaching assignment, and evaluate the student upon completion of assignment. Prerequisite: Master's level standing.

CSE 794. Master's Supervised Research**Credits 3(3-0)**

This course is supervised research under the mentorship of a faculty member. It is not intended to serve as the project nor thesis topic of the master's student. Prerequisite: Consent of instructor.

CSE 796. Masters Project**Credit 3(3-0)**

The student will conduct advanced research of interest to the student and the instructor. A written proposal, which outlines the nature of the project, must be submitted for approval. This course is only available to project option students. Prerequisite: Masters level standing.

CSE 797. Masters Thesis**Credit 3(3-0)**

Master of Science thesis research will be conducted under the supervision of the thesis committee chairperson leading to the completion of the Masters thesis. This course is available only to thesis option students and can be repeated. Prerequisite: Consent of advisor.

CSE 799. Continuation of Masters Thesis**Credit 1(1-0)**

This course is a continuation of CSE 797. The course is for master's students who have completed all required credit hour requirements. Prerequisite: Completion of all Thesis/Dissertation Credits.

Computer Science

Gerry Dozier, Chairperson
Huiming (Anna) Yu, Director of Graduate Studies
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OBJECTIVES

The Master of Science Program in Computer Science is designed to meet the need for technical and managerial specialists in research, academia and industry.

DEGREE OFFERED

Computer Science - Master of Science

The MSCS program provides three methods for earning the degree: Thesis (30 credits), Project (33 credits) or course only (33 credits). Unconditional admission to the program is granted to students with a BS in computer science from an accredited program with a minimum GPA of 3.0. Admission may be awarded to promising students from other majors after completing specified undergraduate prerequisites. Specific degree and admission requirements are detailed in the Computer Science Department Graduate Student Handbook.

It is assumed that all entering students have completed undergraduate courses in programming in an object-oriented language (such as C++, Java or Smalltalk), in data structures, algorithm analysis, operating systems and computer architecture. It is also assumed that they are mathematically mature (for example, calculus, discrete math or switching theory). Students who have not had such courses or their equivalent may be required to take undergraduate courses to remedy deficiencies, with no credit towards the degree.

Master's Program General Description

The research interests of the faculty cover many areas of Computer Science including software engineering, information assurance, artificial intelligence, computational science, distributed systems, multiagent systems, computer security, visualization, multimedia input and high performance computing.

Software Engineering:

The systematic approach to the development, operation, maintenance, and retirement of software is the definition of software engineering. Software is not only the program code, but includes the various documents needed for the development, installation, utilization, and maintenance of a system. Engineering refers to the application of a systems approach to the production of large software systems. Methodologies for analysis and design are evolving, competing, and themselves being automated through the use of CASE (computer aided software engineering) tools. The methods of software engineering seek to produce systems of high quality, on time, at the lowest costs possible. Research projects include object oriented methodologies, software production cost modeling, software reliability engineering, and the social implications of computer technology.

Information Assurance:

With wide spread use of the Internet, Information Assurance has become a dominant issue in the Information Technology (IT) industry. Information Assurance has significantly influenced priorities for IT education, research, and development. To defend our homeland and stay at the forefront of scientific discovery, federal and local governments recognize the need for a well-trained workforce in emerging and advanced tools of information security. The rapid growth of Information Assurance in the job market created a need for well-trained workers at all levels, including the master's. Research topics include network security, Web security, wireless security, intrusion detection, information privacy and security, and software development security.

Computational Science and Engineering:

Computational science is a relatively new branch of science and has emerged as a powerful and indispensable method of analyzing a variety of problems in research, production and process development, and manufacturing. Computational modeling and simulation is being accepted as a third methodology in scientific research, complementing the traditional approaches of theory and experiment. Computational modeling, simulation, and visualization are immensely useful for studying things that are otherwise too big, too small, too expensive, too scarce, or too inaccessible