SCHOOL OF COMPUTATIONAL SCIENCE AND ENGINEERING

The School of Computational Science and Engineering (CSE) was established in 2005 to strengthen and better reflect the critical role that computation plays in the science and engineering disciplines at Georgia Tech and the broader technology community. At Georgia Tech, CSE is *the academic discipline devoted to the systematic study and application of computer-based models of natural and engineered systems*. This definition contains two significant elements. First, it acknowledges the essential role that computing and data play in scientific discovery and design and innovation in engineering. Secondly, by referring to CSE as a *discipline*, it recognizes that CSE has its own distinct body of knowledge.

As a school in the College of Computing, CSE supports interdisciplinary research and education in computer science, data science, and applied mathematics. CSE is designed to innovate and create new expertise, technologies, and practitioners.

CSE bridges the gap between traditional computer science (CS) and computational research in science, engineering, medical, and social domains. The School is currently developing programs that immerse students in computing with real-world computational problems and applications. Developing solutions to difficult computation problems that allow all the richness, subtleties, and requirements of the domain to be adequately considered or addressed is crucial.

CSE is concerned with those technologies that lie at the boundary between computer science, data science, and science and engineering. These areas include:

- high performance computing
- scientific and numerical computing
- modeling and simulation
- discrete algorithms
- large-scale data and visual analytics

CSE involves deep collaboration with scientists and engineers, as well as traditional computer scientists. Therefore, school faculty team up with researchers and educators working in high impact areas both at Georgia Tech and at peer research organizations, including national laboratories and industry research labs. Current projects span the following areas:

- aerospace engineering
- computational chemistry
- computational biology and genomics
- civil and environmental engineering
- earth sciences
- health sciences and healthcare informatics
- industrial and systems engineering
- materials science and manufacturing
- mechanical engineering
- neuroscience
- social good and sustainable development
- urban systems and smart cities

Master's Degrees

- Master of Science in Computational Science and Engineering
- Master of Science in Computer Science
- Master of Science in Analytics
- Master of Science in Bioengineering
- Master of Science in BioInformatics

Doctoral Degrees

- Doctor of Philosophy with a Major in Computational Science and Engineering
- Doctor of Philosophy with a Major in Computer Science
- Doctor of Philosophy with a Major in Machine Learning
- Doctor of Philosophy with a Major in Bioengineering
- Doctor of Philosophy with a Major in Bioinformatics

CSE 6001. Introduction to Computational Science and Engineering. 1 Credit Hour.
This course will introduce students to major research areas in computational science and engineering.

CSE 6010. Computational Problem Solving for Scientists and Engineers. 3 Credit Hours.
Computing principles, computer architecture, algorithms and data structure; software development, parallelism. No credit for graduate students or undergraduates in Computer Science or Computational Media.

CSE 6040. Computing for Data Analysis: Methods and Tools. 3 Credit Hours.
Computational techniques needed for data analysis; programming, accessing databases, multidimensional arrays, basic numerical computing, and visualization; hands-on applications and case studies. Credit is will not be awarded for both CSE 6040 and CX 4240.

CSE 6140. Computational Science and Engineering Algorithms. 3 Credit Hours.
This course will introduce students to designing high-performance and scalable algorithms for computational science and engineering applications. The course focuses on algorithms design, complexity analysis, experimentation, and optimization, for important science and engineering applications.

CSE 6141. Massive Graph Analysis. 3 Credit Hours.
Algorithms and data structures for massive graphs; programming, parallelism; principles, challenges, opportunities in graph analysis; hands-on application, case studies.

CSE 6220. High Performance Computing. 3 Credit Hours.
This course will introduce students to the design, analysis, and implementation of high performance computational science and engineering applications.

CSE 6221. Multicore Computing: Concurrency and Parallelism on the Desktop. 3 Credit Hours.
This course will introduce students to the design and analysis of real-world algorithms on multicore computers.

CSE 6230. High Performance Parallel Computing: Tools and Applications. 3 Credit Hours.
Introduction to MIMD parallel computation, using textbook excerpts, resesarch papers, and projects on multiple parallel machines. Emphasizes practical issues in high-performance computing.

CSE 6236. Parallel and Distributed Simulation. 3 Credit Hours.
Algorithms and techniques used in parallel/distributed discrete event simulation systems. Synchronization algorithms, data distribution, applications to high performance analytic simulations and distributed virtual environments.

CSE 6240. Web Search and Text Mining. 3 Credit Hours.
Basic and advanced methods for Web information retrieval and text mining: indexing and crawling, IR models, link and click data, social search, text classification and clustering.

CSE 6241. Pattern Matching Algorithms. 3 Credit Hours.
Foundations and algorithms underlying the development and application of tools for the efficient searching, matching and discovery of discrete.

CSE 6242. Data and Visual Analytics. 3 Credit Hours.
The course introduces students to analysis and visualization of complex high dimensional data. Both theory and applications will be covered including several practical case studies.

CSE 6243. Advanced Topics in Machine Learning. 3 Credit Hours.
Advanced machine learning topics including graphical models, kernel methods, boosting, bagging, semi-supervised and active learning, and tensor approach to data analysis.

CSE 6250. Big Data Analytics for Healthcare. 3 Credit Hours.
Big data systems, scalable machine learning algorithms, health analytic applications, electronic health records.

CSE 6301. Algorithms for Bioinformatics and Computational Biology. 3 Credit Hours.
Foundations and algorithms underlying the development and application of tools for the efficient management and processing of biomolecular data.

CSE 6643. Numerical Linear Algebra. 3 Credit Hours.
Introduction to numerical solutions of the classical problems of linear algebra including linear systems, least squares, singular value decomposition, and eigen value problems. Crosslisted with MATH 6643.

CSE 6644. Iterative Methods for Systems of Equations. 3 Credit Hours.
Iterative methods for linear and nonlinear systems of equations including Jacobi, G-S, SOR, CG, multigrid, Newton, quasi-Newton, updating, and gradient based methods. Crosslisted with MATH 6644.

CSE 6710. Numerical Methods in Computational Science and Engineering I. 3 Credit Hours.
Introduction to numerical algorithms widely used in computational science and engineering. Numerical linear algebra, linear programming, and applications. Crosslisted with MATH 6710.

CSE 6711. Numerical Methods in Computational Science and Engineering II. 3 Credit Hours.
Efficient numerical techniques for solving partial differential equations and large-scale systems of equations arising from discretization of partial differential equations or variational problems in applications in science and engineering. Crosslisted with MATH 6711.

CSE 6730. Modeling and Simulation: Foundations and Implementation. 3 Credit Hours.
Foundations and algorithms concerning the development of conceptual models for systems, and their realization in the form of computer software; discrete and continuous models. Crosslisted with ECE 6730.

CSE 6740. Computational Data Analysis: Learning, Mining, and Computation. 3 Credit Hours.
Theoretical/computational foundations of analyzing large/complex modern datasets, including the fundamental concepts of machine learning and data mining needed for both resesarch and practice. Crosslisted with ISYE 6740. Credit not awarded for both CSE 6740 and CS 4641/7641/ISYE 6740.

CSE 6742. Modeling, Simulation and Military Gaming. 3 Credit Hours.
Focuses on the creation and use of modeling and simulation tools to analyze and train students regarding strategic events in international relations. Crosslisted with INTA 6742.

CSE 6748. Applied Analytics Practicum. 6 Credit Hours.
Practical analytics project experience applying ideas from the classroom to a significant project of interest to a business, government agency, or other organization.

CSE 6XXX. Comput. Sci. & Engr Elective. 1-21 Credit Hours.

CSE 7000. Master's Thesis. 1-21 Credit Hours.

CSE 7750. Mathematical Foundations of Machine Learning. 3 Credit Hours.
Provides the mathematical background for two of the pillars of modern data science: linear algebra and applied probability.

CSE 7751. Probabilistic Graphical Models in Machine Learning. 3 Credit Hours.
The course provides an introduction to theory and practice of graphical models in machine learning. It covers three main aspects; representation, probabilistic inference, and learning.

CSE 7850. Machine learning in computational biology. 3 Credit Hours.
Introduction to modern machine learning techniques in computational biology.

CSE 7999. Preparation for Doctoral Qualifying Examination. 1-21 Credit Hours.

CSE 7XXX. Comput. Sci. & Engr Elective. 1-21 Credit Hours.

CSE 8001. Computational Science and Engineering Seminar. 1 Credit Hour.
Group discussion concerning advanced topics in Computational Science and Engineering.

CSE 8002. Computational Science and Engineering Seminar. 2 Credit Hours.
Group discussion concerning advanced topics in Computational Science and Engineering.

CSE 8003. Computational Science and Engineering Seminar. 3 Credit Hours.
Group discussion concerning advanced topics in Computational Science and Engineering.

CSE 8004. Computational Science and Engineering Seminar. 4 Credit Hours.
Group discussion concerning advanced topics in Computational Science and Engineering.

CSE 8005. Computational Science and Engineering Seminar. 5 Credit Hours.
Group discussion concerning advanced topics in Computational Science and Engineering.

CSE 8801. Special Topics. 1 Credit Hour.
Topics of current interest in Computational Science and Engineering.

CSE 8802. Special Topics. 2 Credit Hours.
Topics of current interest in Computational Science and Engineering.

CSE 8803. Special Topics. 3 Credit Hours.
Topics of current interest in Computational Science and Engineering.

CSE 8804. Special Topics. 4 Credit Hours.
Topics of current interest in Computational Science and Engineering.

CSE 8805. Special Topics. 5 Credit Hours.
Topics of current interest in Computational Science and Engineering.

CSE 8901. Special Problems. 1-21 Credit Hours.
Small-group or individual investigation of advanced topics with a faculty member.

CSE 8902. Special Problems. 1-21 Credit Hours.
Small-group or individual investigation of advanced topics with a faculty member.

CSE 8903. Special Problems. 1-21 Credit Hours.
Small-group or individual investigation of advanced topics with a faculty member.

CSE 8997. Teaching Assistantship. 1-6 Credit Hours.
For students holding graduate teaching assistantships.

CSE 8998. Research Assistantship. 1-6 Credit Hours.
For students holding graduate research assistantships.

CSE 8999. Doctoral Thesis Preparation. 1-21 Credit Hours.

CSE 8XXX. Comput. Sci & Engr Elective. 1-21 Credit Hours.

CSE 9000. Doctoral Thesis. 1-21 Credit Hours.