DOCTORAL PROGRAMS IN COMPUTATIONAL SCIENCE AND ENGINEERING

Computational Science and Engineering (*https://catalog.mit.edu/interdisciplinary/graduate-programs/computational-science-engineering*)

Doctor of Philosophy in Computational Science and Engineering

Program Requirements

Core Subjects		
18.335[J]	Introduction to Numerical Methods	12
CSE.900	Doctoral Seminar in Computational Science and Engineering	3
Core Area of Study		48
Choose four 12-unit subjects from the core CSE areas in the table below. [1]		
Computational Concentration [1]		**24**
Unrestricted Electives		**24**
Choose 24 units of additional graduate-level subjects in any field.		
Thesis Research		**168-288**
Total Units		**279-399**

Note: Students in this program can choose to receive the Doctor of Philosophy or the Doctor of Science in the chosen field of specialization. Students receiving veterans benefits must select the degree they wish to receive prior to program certification with the Veterans Administration.

[1]   A program of study comprising subjects in the selected core areas and the computational concentration must be developed in consultation with the student's doctoral thesis committee and approved by the CCSE graduate officer.

Core Area Subjects

Computational Modeling

1.545[J]	Atomistic Modeling and Simulation of Materials and Structures [1]	12
1.723	Computational Methods for Flow in Porous Media [1]	12
2.29	Numerical Fluid Mechanics [1]	12
3.320	Atomistic Computer Modeling of Materials [1]	12
4.450[J]	Computational Structural Design and Optimization [1]	
9.660	Computational Cognitive Science [1]	12
10.637[J]	Computational Chemistry [1]	12
12.521	Computational Geophysical Modeling [1]	12
12.850	Computational Ocean Modeling [1]	12
16.225[J]	Computational Mechanics of Materials [1]	12
18.369[J]	Mathematical Methods in Nanophotonics [1]	12
18.417	Introduction to Computational Molecular Biology [1]	12
22.315	Applied Computational Fluid Dynamics and Heat Transfer [1]	12

Discretization and Numerical Methods for Partial Differential Equations

2.098	Introduction to Finite Element Methods	12
6.7300[J]	Introduction to Modeling and Simulation	12
6.8410	Shape Analysis	12
16.920[J]	Numerical Methods for Partial Differential Equations [1]	12
16.930	Advanced Topics in Numerical Methods for Partial Differential Equations	12
18.336[J]	Fast Methods for Partial Differential and Integral Equations [1]	12
22.15	Essential Numerical Methods	6

High-Performance Computing, Software Engineering, and/or Algorithms [2]

6.5060	Algorithm Engineering [1]	12
6.5210[J]	Advanced Algorithms [1]	12
6.5220[J]	Randomized Algorithms	12
6.5250[J]	Distributed Algorithms	12
6.5320	Geometric Computing	12
18.337[J]	Parallel Computing and Scientific Machine Learning [1]	12
18.435[J]	Quantum Computation	12

Inference, Statistical Computing, and Data-Driven Modeling

2.156	Artificial Intelligence and Machine Learning for Engineering Design	12
6.7800	Inference and Information [1]	12
6.7810	Algorithms for Inference	12
6.7830	Bayesian Modeling and Inference	12
6.7900	Machine Learning [1]	12
6.C51	Modeling with Machine Learning: from Algorithms to Applications	6
And one of the following 6-unit co-requisites:		
1.C51	Machine Learning for Sustainable Systems	

2.C51	Physical Systems Modeling and Design Using Machine Learning	
3.C51[J]	Machine Learning for Molecular Engineering	
6.C511	Modeling with Machine Learning for Computer Science	
7.C51	Machine Learning in Molecular and Cellular Biology	
22.C51	Modeling with Machine Learning: Nuclear Science and Engineering Applications	
SCM.C51	Machine Learning Applications for Supply Chain Management	
9.520[J]	Statistical Learning Theory and Applications	12
10.554[J]	Process Data Analytics	12
16.940	Numerical Methods for Stochastic Modeling and Inference [1]	12
IDS.131[J]	Statistics, Computation and Applications	12

Mathematical Foundations [3]

6.7700[J]	Fundamentals of Probability [1]	12
18.1002	Real Analysis [1]	12
18.1011	Analysis and Manifolds [1]	12
18.1021	Introduction to Functional Analysis [1]	12
18.1031	Fourier Analysis: Theory and Applications [1]	12
18.125	Measure Theory and Analysis [1]	12
18.1521	Introduction to Partial Differential Equations [1]	12
18.3541	Nonlinear Dynamics: Continuum Systems [1]	12
18.4041[J]	Theory of Computation	12
18.655	Mathematical Statistics [1]	12
18.675	Theory of Probability [1]	12

Optimization Methods

1.583[J]	Topology Optimization of Structures	12
6.7210[J]	Introduction to Mathematical Programming [1]	12
6.7220[J]	Nonlinear Optimization [1]	12
6.7230[J]	Algebraic Techniques and Semidefinite Optimization	12
6.7940	Dynamic Programming and Reinforcement Learning	12
6.C57[J]	Optimization Methods [1]	12
10.557	Mixed-integer and Nonconvex Optimization	12
15.083	Integer Optimization	12
15.C57[J]	Optimization Methods [1]	12
16.888[J]	Multidisciplinary Design Optimization	12

[1] Subject can be used for the qualification evaluation.

[2] Harvard course COMPSCI 2050 High Performance Computing for Science and Engineering is also an approved subject in this area.

[3] Students can also choose any 12-unit, letter-graded (not P/D/F), graduate-level Mathematics subject numbered 18.1* or higher not listed elsewhere in this approved subject list, though seminar and special tops subjects are generally not allowed.