DOCTORAL PROGRAMS IN COMPUTATIONAL SCIENCE AND 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

Choose four 12-unit subjects from these six core CSE areas:

- Discretization and numerical methods for partial differential equations
- Optimization methods
- Statistics and data-driven modeling
- High-performance computing and/or algorithms
- Mathematical foundations (e.g., functional analysis, probability)
- Modeling (i.e., a subject that treats mathematical modeling in any science or engineering discipline)

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

Computational Concentration Subjects

1.125 Architecting and Engineering Software Systems 12
1.545 Atomistic Modeling and Simulation of Materials and Structures 12
1.583 Topology Optimization of Structures 12
1.723 Computational Methods for Flow in Porous Media 12
2.098 Introduction to Finite Element Methods 12
2.168 Learning Machines 12
2.29 Numerical Fluid Mechanics 12
3.320 Atomistic Computer Modeling of Materials 12
4.450[J] Computational Structural Design and Optimization 12
6.7210[J] Introduction to Mathematical Programming 12
6.7220[J] Nonlinear Optimization 12
6.7230[J] Algebraic Techniques and Semidefinite Optimization 12
6.7250 Optimization for Machine Learning 12
6.7300[J] Introduction to Modeling and Simulation 12
6.7810 Algorithms for Inference 12
6.7830 Bayesian Modeling and Inference 12
6.7900 Machine Learning 2 12
6.7940 Dynamic Programming and Reinforcement Learning 12
6.8300 Advances in Computer Vision 12
6.8410 Shape Analysis 12
6.C51 Modeling with Machine Learning: from Algorithms to Applications 1 6
9.660 Computational Cognitive Science 12
10.551 Systems Engineering 3 9
10.552 Modern Control Design 3 9
10.554[J] Process Data Analytics 12
10.557 Mixed-integer and Nonconvex Optimization 12
10.637[J] Computational Chemistry 12
12.515 Data and Models 12
12.521 Computational Geophysical Modeling 12
12.714 Computational Data Analysis 12
12.805 Data Analysis in Physical Oceanography 12
12.850 Computational Ocean Modeling 12
15.070[J] Discrete Probability and Stochastic Processes 12
15.077[J] Statistical Machine Learning and Data Science 2 12
15.083 Integer Optimization 4 12
15.093[J] Optimization Methods 12

1 Choose 24 units of graduate credit from the list of Computational Concentration subjects (p. ). The concentration subjects must be developed in consultation with the doctoral thesis committee and approved by the CCSE graduate officer.

2 Choose 24 units of graduate credit from the list of Computational Concentration subjects (p. ). The concentration subjects must be developed in consultation with the doctoral thesis committee and approved by the CCSE graduate officer.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>16.110</td>
<td>Flight Vehicle Aerodynamics</td>
<td>12</td>
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<tr>
<td>16.413[J]</td>
<td>Principles of Autonomy and Decision Making</td>
<td>12</td>
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<tr>
<td>16.930</td>
<td>Advanced Topics in Numerical Methods for Partial Differential Equations</td>
<td>12</td>
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<tr>
<td>16.940</td>
<td>Numerical Methods for Stochastic Modeling and Inference</td>
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<tr>
<td>18.335[J]</td>
<td>Introduction to Numerical Methods</td>
<td>12</td>
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<tr>
<td>18.337[J]</td>
<td>Parallel Computing and Scientific Machine Learning</td>
<td>12</td>
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<tr>
<td>18.338</td>
<td>Eigenvalues of Random Matrices</td>
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<td>18.435[J]</td>
<td>Quantum Computation</td>
<td>12</td>
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<td>22.15</td>
<td>Essential Numerical Methods</td>
<td>6</td>
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<td>22.212</td>
<td>Nuclear Reactor Analysis II</td>
<td>12</td>
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<tr>
<td>22.213</td>
<td>Nuclear Reactor Physics III</td>
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<tr>
<td>22.315</td>
<td>Applied Computational Fluid Dynamics and Heat Transfer</td>
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<tr>
<td>IDS.131[J]</td>
<td>Statistics, Computation and Applications</td>
<td>12</td>
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1. Students cannot receive credit without simultaneous completion of 6-unit Common Ground disciplinary module. See description for more information.
2. Credit can only be given for one of 6.7900, 6.867, 15.077, or IDS.147.
3. Students receive credit for either 10.551 or 10.552 as a CSE concentration subject, but not both.
4. Subject to Sloan bidding process.