Master's Degree in Computation for Design and Optimization (CDO)

The CDO program is designed with a common core that serves all engineering disciplines, and an elective component that focuses on particular applications. Students must complete coursework distributed as described below (F = course offered fall semester; S = course offered spring semester). Please consult the MIT Subject Listing (http://student.mit.edu/catalog/index.cgi) for subject descriptions, schedules, and additional details.

Core Subjects (3 courses / 36 units)*

Students are required to take three of four core subjects designed to provide foundation materials needed for the study of more advanced elective topics. The core subjects are chosen from the following:

- **2.096[J] / 6.336[J] / 16.910[J]** Introduction to Numerical Simulation (F)
- **2.097[J] / 6.339[J] / 16.920[J]** Numerical Methods for Partial Differential Equations (F)
- **6.255[J] / 15.093[J]** Optimization Methods (F)
- **6.337[J] / 18.335[J]** Introduction to Numerical Methods (S)

Restricted Electives (2 courses / 24 units)*†

Students choose two graduate level restricted electives (REs) from the following list of specialized subjects that have computational themes and related components, and that are aligned with the program's educational mission:

- **1.124[J] / 2.091[J]** Software and Computation for Simulation (F)
- **1.125** Architecting & Engineering Software Systems (F)
- **1.545** Atomistic Modeling & Simulations of Materials & Structures (F)
- **1.723** Computational Methods for Flow in Porous Media (S)
- **2.089[J] / 1.128[J]** Computational Geometry (S)
- **2.096[J] / 6.336[J] / 16.910[J]** Introduction to Numerical Simulation (F)
- **2.097[J] / 6.339[J] / 16.920[J]** Numerical Methods for Partial Differential Equations (F)
- **2.098** Introduction to Finite Element Methods for Partial Differential Equations (S)
- **2.168** Learning Machines (S)
- **2.29** Numerical Fluid Mechanics (S)
- **3.320** Atomistic Computer Modeling of Materials (S)
- **4.450[J] / 1.575[J]** Computational Structural Design and Optimization (F)
- **6.231** Dynamic Programming and Stochastic Control (S)
- **6.251[J] / 15.081[J]** Introduction to Mathematical Programming (F)
- **6.252[J] / 15.084[J]** Nonlinear Optimization (S)
- **6.255[J] / 15.093[J]** Optimization Methods (F)
- **6.256** Algebraic Techniques and Semidefinite Optimization (S)
- **6.265[J] / 15.070[J]** Discrete Probability and Stochastic Processes *[formerly Advanced Stochastic Processes]* (S)
- **6.337[J] / 18.335[J]** Introduction to Numerical Methods (S)
- **6.438** Algorithms for Inference (F)
- **6.439[J] / IDS.131[J]** Statistics, Computation and Applications (F)
- **6.838** Shape Analysis (S)
- **6.860[J] / 9.520[J]** Statistical Learning Theory and Applications (F)
- **6.864** Advanced Natural Language Processing (F)
- **6.867** Machine Learning (F)
- **6.869** Advances in Computer Vision (F)
- **9.660** Computational Cognitive Science (F)
- **10.557** Mixed-integer and Nonconvex Optimization (S)
- **10.637[J] / 5.698[J]** Quantum Chemical Simulation (F)
- **12.515** Data and Models (F)
- **12.521** Computational Geophysical Modeling (F)

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Restricted Electives Cont. (2 courses / 24 units)*†

- **12.620** Classical Mechanics: A Computational Approach (F)
- **12.714** Computational Data Analysis (S)
- **12.805** Data Analysis in Physical Oceanography (S)
- **12.850** Computational Ocean Modeling (S)
- **15.077[J] / IDS.211[J]** Statistical Learning and Data Mining (S; Cannot be used if taken Fall 2015 or after & credit also received for 6.867)
- **15.083** Integer Programming and Combinatorial Optimization (S; Sloan bidding process required)
- **15.764[J] / 1.271[J]** Theory of Operations Management (S)
- **16.110** Flight Vehicle Aerodynamics (F)
- **16.225[J] / 2.099[J]** Computational Mechanics of Materials (S)
- **16.413** Principles of Autonomy and Decision Making (F)
- **16.888[J] / IDS.338[J]** Multidisciplinary Design Optimization (S)
- **16.930** Advanced Topics in Numerical Methods for Partial Differential Equations (S)
- **16.940** Numerical Methods for Stochastic Modeling & Inference (F)
- **18.336[J] / 6.335[J]** Fast Methods for Partial Differential and Integral Equations (F)
- **18.337[J] / 6.338[J]** Numerical Computing and Interactive Software *[formerly Parallel Computing]* (F)
- **18.369** Mathematical Methods in Nanophotonics (S)
- **22.15** Essential Numerical Methods (F; first ½ of term)
- **22.212** Nuclear Reactor Analysis II (F)
- **22.213** Nuclear Reactor Physics III (S)
- **22.315** Applied Computational Fluid Dynamics and Heat Transfer (S)

Unrestricted Elective (1 course / 12 units)*

Students may choose any **graduate-level 12-unit subject** to satisfy the unrestricted elective (UE) component.

**Courses that can be repeated for credit cannot be used to satisfy multiple CDO requirements.*

Thesis (36 units)

Concurrent with coursework, students conduct thesis research leading to the writing of a master's thesis under the supervision of a faculty advisor. Students must register for CDO.THG each term they are conducting thesis research as well as the term immediately prior to graduating, e.g. IAP for February degree list and summer term for September degree list. Thesis research progress will be assessed on a continuing basis with students receiving either a 'J' / 'satisfactory' or 'U' / 'unsatisfactory' at the end of each term. Upon completion of the final thesis students will receive a traditional letter grade; this letter grade will appear by itself in the term the thesis was completed and next to the J or U in prior terms (e.g. J/A).

English Language Proficiency

All incoming CDO students are required to take the MIT Graduate Writing Exam (GWE) administered by the Writing, Rhetoric, and Professional Communication program (WRAP). **Students who do not receive a score of 75 or higher are required to take 21W.794 Graduate Technical Writing Workshop**. Students may choose to take the workshop with P/D/F grading (rather than an A-F letter grade), however they must receive a P grade.

Academic Performance

CDO students are expected to maintain a cumulative grade point average (GPA) of at least 4.5 out of 5.0. If a student's term GPA is at or below 4.0 for two sequential terms, if an unsatisfactory grade ('U') is given for CDO.THG, or if a grade of C or lower is given in any subject, a warning from the CDO directors will be issued to the student. All situations are handled on a case by case basis, and additional action(s), including a Vice Chancellor's warning up to denial of further registration, may be taken if necessary.

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†*Previously Approved REs No Longer Included*

- 1.204 Computer Modeling: From Human Mobility to Transportation Networks (no longer offered)
- 2.092 / 2.093 Finite Element Analysis of Solids and Fluids I (no longer offered)
- 2.094 Finite Element Analysis of Solids and Fluids II (no longer offered)
- 2.37 Fundamentals of Nanoengineering (cannot be used if taken Spring 2020 or later)
- 6.673 Introduction to Numerical Simulation in Electrical Engineering (no longer offered)
- 6.581[J] / 20.482[J] Foundations of Algorithms and Computational Techniques in Systems Biology (no longer offered)
- 10.34 Numerical Methods in Chemical Engineering (cannot be used if taken Fall 2019 or later)
- 15.062[J] / IDS.145[J] Data Mining: Finding the Data and Models that Create Value (cannot be used if taken Fall 2019 or later)
- 15.074 Predictive Data Analytics and Statistical Modeling (no longer offered)
- 15.082 Network Optimization (no longer offered)
- 18.0851 Computational Science and Engineering I (cannot be used if taken Fall 2018 or later)
- 18.0861 Computational Science and Engineering II (cannot be used if taken Fall 2018 or later)
- 22.107 Computational Nuclear Science and Engineering (no longer offered)