<table>
<thead>
<tr>
<th>Aeronautics and Astronautics</th>
<th>Biological Engineering</th>
<th>Brain and Cognitive Sciences</th>
<th>Chemical Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.080J; 2.183J; (16.32 or 6.7940J); (16.31 or 16.338J); 16.422; 16.423J; 16.453J; 16.463; (16.851J or 16.89J); (16.910J or 6.920J); 22.55J; HST.582J</td>
<td>choose BOTH 20.420J and 20.440</td>
<td>choose ONE 9.011 or HST.131</td>
<td>choose at least TWO 10.40; 10.50; 10.65</td>
</tr>
<tr>
<td></td>
<td>20.203J; 20.215; 20.409; 20.446J; 20.452J; 20.470J; 20.475; HST.507J; HST.508; HST.522J; HST.523J; HST.537J; HST.538J</td>
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<tr>
<td>Chemistry</td>
<td>Computer Science</td>
<td></td>
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<tr>
<td>42 UNITS required, may need 5 subjects</td>
<td>choose TWO from one group and ONE from each of the other groups</td>
<td></td>
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<tr>
<td>5.05; 5.061; 5.062; 5.068; 5.44 5.45; 5.46; 5.511; 5.512; 5.52; 5.53; 5.541; 5.56; 5.64J; 5.68J; 5.698J; 5.70J; 5.72; 5.73; 5.74; 5.78; 5.83; 7.51; 10.569; [20.51 + 6.51]; 20.201; 20.420; 20.463J; BCMP 250 (HU); CHEM 170 (HU)</td>
<td>Algorithms 6.1220J; 6.5210J; 6.5220J; 6.5250J; 6.7310J; 6.7320J</td>
<td></td>
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</tr>
<tr>
<td>Materials Science and Engineering</td>
<td>Mechanical Engineering</td>
<td>Nuclear Science and Engineering</td>
<td>Physics</td>
</tr>
<tr>
<td>Choose BOTH 3.20 and 3.21</td>
<td>choose at least TWO from the first group; if you choose more you may include from sets marked with *</td>
<td>42 UNITS required, may need 5 subjects</td>
<td>No more than TWO from the first group</td>
</tr>
<tr>
<td>3.22; 3.23; 3.40J; 3.46; 3.941J; 3.942; (3.963J or 3.971J)</td>
<td>2.032; 2.066; (2.071 or 2.072 or 2.080J)<em>; (2.097J or 2.29)</em>; (2.140 or 2.151 or 2.153)*; 2.25; 2.37; 2.42; 2.55; 2.675; (2.710 or 6.6310); 2.75J; (2.720 or 2.77); (2.794J; 2.795J or 2.798)*2.810</td>
<td>22.11; 22.12; 22.13; 22.14; 22.15; 22.51J; 22.55J</td>
<td>8.59J; 8.592J; 8.593J</td>
</tr>
<tr>
<td></td>
<td>2.183J; 2.341J; 2.372J; 2.740, (2.782J or 2.785J or 2.79J or 3.963J); 3.23; HST.537J; HST.582</td>
<td></td>
<td>8.311; 8.321; 8.322; 8.333; 8.334; 8.351J; 8.421; 8.422; 8.511; 8.512; 8.613J; 8.701</td>
</tr>
</tbody>
</table>
Aeronautics and Astronautics
2.080J Structural Mechanics
2.183J Biomechanics and Neural Control of Movement
(16.31 Feedback Control Systems OR 16.338 Dynamic Systems & Control)
16.422 Human Supervisory Control of Automated Systems
16.423J Aerospace Biomedical and Life Support Engineering
16.453J Human Systems Engineering
16.470 Statistical Methods in Experimental Design
(16.851 Satellite Engineering OR 16.89J Space Systems Engineering)
22.55J Radiation Biophysics
HST.582J Biomedical Signal and Image Processing

Biological Engineering
You must choose both 20.420J and 20.440.
20.420J Principles of Molecular Bioengineering AND
20.440 Analysis of Biological Networks
Choose at least one:
20.201 Fundamentals of Drug Development
20.405J Principles of Synthetic Biology
20.410J Molecular, Cellular, and Tissue Biomechanics
20.415 Physical Biology
20.430J Fields, Forces, and Flows in Biological Systems
20.463J Biomaterials Science and Engineering
20.490 Computational Systems Biology: Deep Learning in the Life Sciences

Other approved subjects:
20.203J Neurotechnology in Action
20.215 Macroepidemiology, Population Genetics & Stem Cell Biology of Human Clonal Diseases
20.409 Biological Engineering II: Instrumentation and Measurement
20.446J Microbial Genetics and Evolution
20.452J Principles of Neuroengineering
20.470J Cellular Neurophysiology and Computing
20.475 Applied Developmental Biology and Tissue Engineering
HST.507J Advanced Computational Biology: Genomes, Networks, Evolution
HST.508 Evolutionary and Quantitative Genomics
HST.522J Biomaterials: Tissue Interactions
HST.523J Cell-Matrix Mechanics
HST.537J Fluids and Diseases
HST.538J Genomics and Evolution of Infectious Disease
Brain and Cognitive Sciences

**Choose one (not both):**
(9.011 Systems Neuroscience Core I OR HST.131 Neuroscience)

**Choose at least one:**
- 9.012 Cognitive Science
- 9.013J Molecular and Cellular Neuroscience Core II
- 9.014 Quantitative Methods and Computational Models in Neurosciences
- 9.015J Molecular and Cellular Neuroscience Core I
- 9.017 Systems Neuroscience Core II

**Other approved subjects:**
- 9.021J Cellular Neurophysiology and Computing
- 9.073J Statistics for Neuroscience Research
- 9.123J Neurotechnology in Action
- 9.181J Developmental Neurobiology
- 9.301J Neural Plasticity in Learning and Memory
- 9.422J Principles of Neuroengineering
- 9.520J Statistical Learning Theory and Applications
- 9.611J Natural Language and the Computer Representation of Knowledge
- 9.660 Computational Cognitive Science
- HST.562J Pioneering Technologies for Interrogating Complex Biological Systems
- HST.580J Data Acquisition and Image Reconstruction in MRI
- HST.582J Biomedical Signal and Image Processing

Chemical Engineering

**Choose at least two:**
- 10.40 Chemical Engineering Thermodynamics
- 10.50 Analysis of Transport Phenomena
- 10.65 Chemical Reactor Engineering

**Other approved subjects:**
- 10.34 Numerical Methods Applied to Chemical Engineering
- 10.531J Macromolecular Hydrodynamics
- 10.537J Molecular, Cellular, and Tissue Biomechanics
- 10.538J Principles of Molecular Bioengineering
- 10.539J Fields, Forces, and Flows in Biological Systems
- 10.542 Biochemical Engineering
- 10.545 Fundamentals of Metabolic and Biochemical Engineering: Applications to Biomanufacturing
- 10.546J Statistical Thermodynamics
- 10.55 Colloid and Surfactant Science
- 10.562J Pioneering Technologies for Interrogating Complex Biological Systems
- 10.566 Structure of Soft Matter
- 10.568 Physical Chemistry of Polymers
- 10.569 Synthesis of Polymers
- 10.595 Molecular Design and Bioprocess Development of Immunotherapies
- 10.643J Future Medicine: Drug Delivery, Therapeutics, and Diagnostics
- 10.668J Statistical Mechanics of Polymers
Chemistry

*Your TQE course selections must total at least 42 units, so it may be necessary to take five classes instead of the usual four.*

- 5.05 Principles of Inorganic Chemistry III
- 5.061 Principles of Organometallic Chemistry
- 5.062 Principles of Bioinorganic Chemistry
- 5.068 Physical Inorganic Chemistry
- 5.44 Organometallic Chemistry
- 5.45 Heterocyclic Chemistry
- 5.46 NMR Spectroscopy and Organic Structure Determination
- 5.511 Synthetic Organic Chemistry I
- 5.512 Synthetic Organic Chemistry II
- 5.52 Tutorial in Chemical Biology
- 5.53 Molecular Structure and Reactivity
- 5.54J Frontiers in Chemical Biology
- 5.56 Molecular Structure and Reactivity II
- 5.64J Frontiers of Interdisciplinary Science in Human Health and Disease
- 5.68J Kinetics of Chemical Reactions
- 5.698J Computational Chemistry
- 5.70J Statistical Thermodynamics
- 5.72 Statistical Mechanics
- 5.73 Introductory Quantum Mechanics I
- 5.74 Introductory Quantum Mechanics II
- 5.78 Biophysical Chemistry Techniques
- 5.83 Advanced NMR Spectroscopy
- 7.51 Principles of Biochemical Analysis
- 10.569 Synthesis of Polymers


- 20.201 Fundamentals of Drug Development
- 20.420 Principles of Molecular Bioengineering
- 20.463J Biomaterials Science and Engineering
- BCMP 250 Biophysical and Biochemical Mechanisms of Protein Function (Harvard)
- CHEM 170 Chemical Biology (Harvard)

Computer Science

*Select two courses from one group and one from each of the other groups.*

*Algorithms*

- 6.1220J Design and Analysis of Algorithms
- 6.5210J Advanced Algorithms
- 6.5220J Randomized Algorithms
- 6.5250J Distributed Algorithms
- 6.7310J Introduction to Numerical Methods
- 6.7320J Parallel Computing and Scientific Machine Learning
Probability and/or Statistics
6.770J Fundamentals of Probability
6.7800 Inference and Information
6.7810 Algorithms for Inference
6.7900 Machine Learning
9.520J Statistical Learning Theory and Applications
15.077J Statistical Machine Learning and Data Science
16.391J Statistics for Engineers and Scientists
HST.460J Statistics for Neuroscience Research
STAT 211 Statistical Inference I (Harvard)

[Students without a strong background in probability are encouraged to take 6.3702 Introduction to Probability before attempting one of the TQE classes listed above.]

Applications
2.740 Bio-inspired Robotics
6.4812J Cellular Neurophysiology and Computing
6.8210 Underactuated Robotics
6.8300 Advances in Computer Vision
6.8420 Advanced Computer Graphics
(6.8610 Advanced Natural Language Processing OR 6.8620J Spoken Language Processing OR 6.8630J Natural Language and the Computer Representation of Knowledge)
6.8700J Advanced Computational Biology: Genomes, Networks, Evolution
6.8710J Computational Systems Biology: Deep Learning in the Life Sciences
6.8800J Biomedical Signal and Image Processing
6.8810J Data Acquisition and Image Reconstruction in MRI
8.591J Systems Biology
18.417 Introduction to Computational Molecular Biology
HST.508 Evolutionary and Quantitative Genomics
HST.538J Genomics and Evolution of Infectious Disease
HST.956J Machine Learning for Healthcare
Biophys 205 Computational and Functional Genomics (Harvard)

• You may not choose more than one class of the following: 6.8610J, 6.8620J, 6.8630J

Electrical Engineering
Select two courses from one group and one from each of two additional groups.
System Science and Control Engineering:
6.3010 Signals, Systems and Inference
(6.7100J Dynamic Systems and Control OR 6.7940 Dynamic Programming and Reinforcement Learning)
6.8810J Data Acquisition and Image Reconstruction in MRI
HST.584J Magnetic Resonance Analytic, Biochemical, and Imaging Techniques

Updated 8.23.2022
HST MEMP TQE Concentration Area Subjects

Circuits and Electronic Systems
6.4861J Medical Device Design
6.6000 CMOS Analog and Mixed-Signal Circuit Design
6.6010 Analysis and Design of Digital Integrated Circuits
6.6620 Power Electronics

Information Science and Communication
6.7410 Principles of Digital Communication
6.7420 Heterogeneous Networks: Architecture, Transport, Protocols, and Management
6.7470 Information Theory
6.7700J Fundamentals of Probability
6.7710 Discrete Stochastic Processes
(6.7800 Inference and Information OR 6.7810 Algorithms for Inference)
6.7900 Machine Learning
6.8300 Advances in Computer Vision

Electromagnetics
6.4832J Fields, Forces, and Flows in Biological Systems
6.6280 Electric Machines
6.6300 Electromagnetics
(6.6310 Optics and Photonics OR 2.710 Optics)
6.6340J Nonlinear Optics

Physical Science and Engineering
6.4812J Cellular Neurophysiology and Computing
6.6500J Integrated Microelectronic Devices
6.6400 Applied Quantum and Statistical Physics
6.6510 Physics for Solid-State Applications

Other

Materials Science and Engineering
Choose both:
3.20 Materials at Equilibrium AND 3.21 Kinetic Processes in Materials

Other approved subjects:
3.22 Structure and Mechanics of Materials
3.23 Electrical, Optical, and Magnetic Properties of Materials
3.40J Modern Physical Metallurgy
3.46 Photonic Materials and Devices
3.941J Statistical Mechanics of Polymers
3.942 Polymer Physics
(3.963J Biomaterials Science and Engineering OR 3.971J Molecular, Cellular, and Tissue Biomechanics)
HST MEMP TQE Concentration Area Subjects

**Mechanical Engineering**

*Choose at least two (if you choose three or four from this group, you may include classes from the same set marked with *):

- 2.032 Dynamics
- 2.066 Acoustics and Sensing
- (2.071 Mechanics of Solid Materials OR 2.072 Mechanics of Continuous Media OR 2.080J Structural Mechanics)
- (2.097J Numerical Methods for Partial Differential Equations OR 2.29 Numerical Fluid Mechanics)

- 2.25 Fluid Mechanics
- 2.37 Fundamentals of Nanoengineering
- 2.42 General Thermodynamics
- 2.55 Advanced Heat and Mass Transfer
- 2.675 Micro/Nano Engineering Laboratory
- (2.710 Optics OR 6.631 Optics and Photonics)
- 2.75J Medical Device Design
- (2.720 Elements of Mechanical Design OR 2.77 FUNdaMENTALS of Precision Product Design)
- (2.794J Cellular Neurophysiology and Computing OR 2.795J Fields, Forces, and Flows in Biological Systems OR 2.798J Molecular, Cellular, and Tissue Biomechanics)
- 2.810 Manufacturing Processes and Systems

**Other approved subjects:**

- 2.183J Biomechanics and Neural Control of Movement
- 2.341J Macromolecular Hydrodynamics
- 2.372J Design and Fabrication of MEMS
- 2.740 Bio-inspired Robotics
- (2.782J Design of Medical Devices and Implants OR 2.785J Cell-Matrix Mechanics OR 2.79J Biomaterials:
  - Tissue Interactions OR 3.963J Biomaterials Science and Engineering)
- 3.23 Electrical, Optical, and Magnetic Properties of Materials
- HST.537J Fluids and Diseases
- HST.582J Biomedical Signal and Image Processing

**Nuclear Science and Engineering**

*Your TQE course selections must total at least 42 units, so it may be necessary to take five classes instead of the usual four.*

- 22.11 Applied Nuclear Physics
- 22.12 Radiation Interactions, Control, and Measurement
- 22.13 Nuclear Energy Systems
- 22.14 Materials in Nuclear Engineering
- 22.15 Essential Numerical Methods
- 22.51J Quantum Technology and Devices
- 22.55J Radiation Biophysics
Physics

No more than two:
8.591J Systems Biology
8.592J Statistical Physics in Biology
8.593J Biological Physics

Other approved subjects:
8.311 Electromagnetic Theory I
8.321 Quantum Theory I
8.322 Quantum Theory II
8.333 Statistical Mechanics I
8.334 Statistical Mechanics II
8.351J Classical Mechanics: A Computational Approach
8.421 Atomic and Optical Physics I
8.422 Atomic and Optical Physics II
8.511 Theory of Solids I
8.512 Theory of Solids II
8.613J Introduction to Plasma Physics I
8.701 Introduction to Nuclear and Particle Physics