<table>
<thead>
<tr>
<th>Aeronautics and Astronautics</th>
<th>Biological Engineering</th>
<th>Brain and Cognitive Sciences</th>
<th>Chemical Engineering</th>
<th>Chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.080J; 2.183J; (6.231 or 16.32); (6.241J or 16.31); 16.422; 16.423J; 16.453J; 16.470; (16.851J or 16.891J); (16.910J or 16.920J); 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>
<td>42 UNITS required, may need 5 subjects</td>
</tr>
</tbody>
</table>

**Computer Science**

- choose TWO from one group and ONE from each of the other groups

| 6.046J; 6.337J; 6.338J; 6.852J; 6.854J; 6.856J | 6.011; (6.231 or 6.241J); (6.251J or 6.255J); (6.341 or 6.344 or 6.555J); 6.556J | 3.22; 3.23; 3.40J; 3.46; 3.54J; 3.94J; (3.963J or 3.971J) |
| 6.521; 6.555J; 6.556J; 6.682; 6.872J; 6.874J; 6.878J; 8.591J; 18.417; (6.345J or 6.863J or 6.864J); (6.866 or 6.869); (6.831 or 6.839); 6.832; HST.508; HST.956; BioPhys 205 | 6.262; 6.267; 6.436J; (6.437 or 6.438); 6.441; 6.450; 6.453; 6.867 | |

**Electrical Engineering**

- choose TWO from one group and ONE from each of two additional groups

| (6.630 or 6.632); (6.631 or 2.710); 6.634J; 6.561J; 6.685 | 6.521J; 6.720J; 6.728; 6.730; 6.774; 6.777J; (6.336J or 6.339J) | |
| 6.334; 6.374; 6.525J; 6.775 | |

**Materials Science and Engineering**

| choose BOTH 3.20 and 3.21 | |
| 3.22; 3.23; 3.40J; 3.46; 3.54J; 3.94J; (3.963J or 3.971J) | |

**Mechanical Engineering**

- choose at least TWO from the first group; if you choose three or four from the first group, you may include classes from the same set marked with *

| 2.032; (2.071 or 2.072 or 2.080J)*; (2.140 or 2.151 or 2.153)*; 2.25; 2.37; 2.42; 2.55; (2.710 or 6.631)*; 2.810; 2.066; (2.097J or 2.29)*; (2.720 or 2.77); (2.974J; 2.795J or 2.798)* | 22.11; 22.12; 22.13; 22.14; 22.15; 22.51; 22.55J | |
| 2.183J; 2.372J; 2.75J; (2.782J or 2.785J or 2.79J or 3.963J); HST.537J | | |

**Nuclear Science and Engineering**

- 42 UNITS required; may need 5 subjects

| 8.591J; 8.592J; 8.593J | 8.311; 8.321; 8.322; 8.333; 8.334; 8.351J; 8.421; 8.422; 8.511; 8.512; 8.613J; 8.701 | |

**Physics**

- No more than TWO from the first group

| 22.11; 22.12; 22.13; 22.14; 22.15; 22.51; 22.55J | 8.591J; 8.592J; 8.593J | |

1.24.2019
HST MEMP TQE Concentration Area Subjects

Updated 1.24.2019

Aeronautics and Astronautics
2.080J Structural Mechanics
2.183J Biomechanics and Neural Control of Movement
6.231 Dynamic Programming and Stochastic Control OR 16.32 Principles of Optimal Control & Estimation
6.241J Dynamic Systems & Control OR 16.31 Feedback Control Systems
16.422J Human Supervisory Control of Automated Systems
16.423J Aerospace Biomedical and Life Support Engineering
16.453J Human Systems Engineering
16.470J Statistical Methods in Experimental Design
16.851J 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 20.420 and 20.440.
20.420J Principles of Molecular Bioengineering AND
20.440J Analysis of Biological Networks
Choose at least one:
20.201J Fundamentals of Drug Development
20.405J Principles of Synthetic Biology
20.410J Molecular, Cellular, and Tissue Biomechanics
20.415J Physical Biology
20.430J Fields, Forces, and Flows in Biological Systems
20.463J Biomaterials Science and Engineering
20.490J Foundations of Computational & Systems Biology
Other approved subjects:
20.203J Neurotechnology in Action
20.207J Biotechnologies in Infectious Disease
20.215J Macroepidemiology, Population Genetics & Stem Cell Biology of Human Clonal Diseases
20.409J Biological Engineering II: Instrumentation and Measurement
20.446JJ Microbial Genetics and Evolution
20.452J Principles of Neuroengineering
20.470J Cellular Neurophysiology and Computing
HST.508J Evolutionary Genomics
HST.522J Biomaterials: Tissue Interactions
HST.523J Cell-Matrix Mechanics
HST.537J Fluid Dynamics and Disease

Brain and Cognitive Sciences
Choose one (not both):
9.011 Systems Neuroscience OR HST.131 Neuroscience
Choose at least one:
9.012J Cognitive Science
9.013J Molecular and Cellular Neuroscience Core II
9.014J Quantitative Methods and Computational Models in Neurosciences
9.015J Molecular and Cellular Neuroscience Core I
9.017J Neural Mechanisms of Cognitive Computations
Other approved subjects:
9.021J Cellular Neurophysiology and Computing
9.073J Statistics for Neuroscience Research
9.160J Cellular & Synaptic Neurophysiology
9.123J Neurotechnology in Action
9.181J Developmental Neurobiology
9.301J Neural Plasticity in Learning and Memory
9.322J Genetic Methods in Neurobiology
9.422J Principles of Neuroengineering
9.520J Statistical Learning Theory and Applications
9.601J Language Acquisition I
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
HST.721 The Biology of the Inner Ear

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
10.537J 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.*

5.062 Principles of Bioinorganic Chemistry
5.45 Heterocyclic Chemistry
5.511 Synthetic Organic Chemistry I
5.52 Advanced Biological Chemistry
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
5.70J Statistical Thermodynamics
5.72 Statistical Mechanics
5.73 Introductory Quantum Mechanics I
5.74 Introductory Quantum Mechanics II
5.78 Biophysical Chemistry Techniques
7.51 Principles of Biochemical Analysis
10.569 Synthesis of Polymers
20.201 Fundamentals of Drug Development
20.463J Biomaterials Science and Engineering
Computer Science
Select two courses from one group and one from each of the other groups.

Algorithms
6.046J Design and Analysis of Algorithms
6.337J Introduction to Numerical Methods
6.338J Numerical Computing and Interactive Software
6.852J Distributed Algorithms
6.854J Advanced Algorithms
6.856J Randomized Algorithms

Probability and/or Statistics
6.434J Statistics for Engineers and Scientists
6.436J Fundamentals of Probability
6.437 Inference and Information
6.438 Algorithms for Inference
6.867 Machine Learning
9.520J Statistical Learning Theory and Applications
15.077J Statistical Learning and Data Mining
HST.460J Statistics for Neuroscience Research
STAT.211 Statistical Inference (Harvard)
[Students without a strong background in probability are encouraged to take 6.431A Introduction to Probability before attempting one of the TQE classes listed above.]

Applications
6.521J Cellular Neurophysiology and Computing
6.555J Biomedical Signal and Image Processing
6.556J Data Acquisition and Image Reconstruction in MRI
6.862 Applied Machine Learning
6.872J Biomedical Computing
6.874J Computational Systems Biology
6.878J Advanced Computational Biology: Genomes, Networks, Evolution
8.591J Systems Biology
18.417 Introduction to Computational Molecular Biology
6.345J Automatic Speech Recognition OR 6.863J Natural Language and the Computer Representation of Knowledge OR 6.864 Advanced Natural Language Processing
6.866 Machine Vision OR 6.869 Advances in Computer Vision
6.832 Underactuated Robotics
HST.508 Evolutionary Genomics
Biophysics 205 (formerly HST.509) Computational and Functional Genomics
HST.956 Machine Learning for Healthcare
[Students with no background in computational biology may wish to take 7.91J Foundations of Computational and Systems Biology before attempting some of the TQE classes listed above.]

• You may not choose more than one class of the following: 6.345J, 6.863J, 6.864
• You may not choose both 6.866 and 6.869
• You may not choose both 6.831 and 6.839

Electrical Engineering
Select two courses from one group and one from each of two additional groups.

System Science and Control Engineering:
6.011 Signals, Systems and Inference
6.231 Dynamic Programming and Stochastic Control or 6.241J Dynamic Systems and Control
6.251J Introduction to Mathematical Programming OR 6.255J Optimization Methods
6.556J Data Acquisition and Image Reconstruction in MRI
**Circuits and Electronic Systems**
6.334 Power Electronics
6.374 Analysis and Design of Digital Integrated Circuits
6.525J Medical Device Design
6.775 CMOS Analog and Mixed-Signal Circuit Design

**Information Science and Communication**
6.262 Discrete Stochastic Processes
6.267 Heterogeneous Networks: Architecture, Transport, Protocols, and Management
6.436J Fundamentals of Probability
6.437 Inference and Information OR 6.438 Algorithms for Inference
6.441 Information Theory
6.450 Principles of Digital Communication
6.453 Quantum Optical Communication
6.867 Machine Learning

**Electromagnetics**
6.630 Electromagnetics OR 6.632 Electromagnetic Wave Theory
6.631 Optics and Photonics OR 2.710 Optics
6.634J Nonlinear Optics
6.561J Fields, Forces, and Flows in Biological Systems
6.685 Electric Machines

**Physical Science and Engineering**
6.521J Cellular Neurophysiology and Computing
6.720J Integrated Microelectronic Devices
6.728 Applied Quantum and Statistical Physics
6.730 Physics for Solid-State Applications
6.774 Physics of Microfabrication: Front End Processing
6.777J Design and Fabrication of MEMS

**Other**

**Materials Science and Engineering**

**Choose both:**
3.20 Materials at Equilibrium AND 3.21 Kinetic Processes in Materials

**Other approved subjects:**
3.22 Mechanical Behavior of Materials
3.23 Electrical, Optical, and Magnetic Properties of Materials
3.40J Modern Physical Metallurgy
3.46 Photonic Materials and Devices
3.54J Corrosion: The Environmental Degradation of Materials
3.941J Statistical Mechanics of Polymers
3.963J Biomedical Science and Engineering OR 3.971J Molecular, Cellular, and Tissue Biomechanics

**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
*2.071 Mechanics of Solid Materials OR 2.072 Mechanics OR Continuous Media OR 2.080J Structural Mechanics*
2.140 Analysis and Design of Feedback Control Systems OR 2.151 Advanced System Dynamics and Control OR 2.153 Adaptive Control*

2.25 Fluid Mechanics
2.37 Fundamentals of Nanoengineering
2.42 General Thermodynamics
2.55 Advanced Heat and Mass Transfer
2.710 Optics OR 6.631 Optics and Photonics
2.810 Manufacturing Processes and Systems
2.066 Acoustics and Sensing

*2.097J Numerical Methods for Partial Differential Equations OR 2.29 Numerical Fluid Mechanics*

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

**Other approved subjects:**
2.183J Biomechanics and Neural Control of Movement
2.372J Design and Fabrication of MEMS
2.75J Medical Device Design
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

2.799 The Cell as a Machine
HST.537J Fluid Dynamics and Disease

**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
22.51 Quantum Theory of Radiation Interactions
22.55J Radiation Biophysics

**Physics**

*No more than two of these:*
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