HST MEMP TQE Concentration Areas ~ Approved Subjects Grid

Aeronautics and Astronautics	Biological Engineering	Brain and Cognitive Sciences	Chemical Engineering	Chemistry
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** 16.89J); (16.910J **or** 16.920J); 22.55J; HST.582J	*choose BOTH* 20.420J **and** 20.440 *choose at least ONE* 20.201; 20.405J; 20.410J; 20.415; 20.430J; 20.463J; 20.490 20.203J; 20.207; 20.215; 20.409; 20.446J; 20.452J; 20.470J; HST.522J; HST.523J, HST.537J	*choose ONE* 9.011 **or** HST.131 *choose at least ONE* 9.012; 9.013J; 9.015J 9.014; 9.021; 9.073J; 9.160; 9.181J; 9.285J; 9.301J; 9.322J; 9.422J; 9.520J; 9.601J; 9.611J; 9.660; HST.580J; HST.582J; HST.721	*choose at least TWO* 10.40; 10.50; 10.65 10.34; 10.537J; 10.538J; 10.539J; 10.542; 10.545; 10.546J; 10.55; 10.562; 10.566; 10.568; 10.569; 10.595; 10.643J; 10.668J;	*42 UNITS required, may need 5 subjects* 5.062; 5.45; 5.511; 5.52; 5.53; 5.56; 5.64J; 5.68J; 5.70J; 5.72; 5.73; 5.74; 5.78; 7.51; 10.569; 20.201, 20.463J

Computer Science		Electrical Engineering		Materials Science and Engineering
choose TWO from one group and ONE from each of the other groups		*choose TWO from one group and ONE from each of two additional groups*		*choose BOTH* 3.20 **and** 3.21
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; 3.941J; (3.963J **or** 3.971J)
6.434J; 6.436J; 6.437; 6.438; 6.867; 9.520J; 15.077J; HST.460J; STAT.211		6.334; 6.374; 6.525J; 6.775		
6.521; 6.555J; 6.556J; 6.872J; 6.874J; 6.878J; 8.591J; 18.417; (6.345J **or** 6.863J **or** 6.864); (6.866 **or** 6.869); (6.831 **or** 6.839); 6.832; HST.508; BioPhys 205		6.262; 6.267; 6.436J; (6.437 **or** 6.438); 6.441; 6.450; 6.453; 6.867		
		(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)		

Mechanical Engineering	Nuclear Science and Engineering	Physics
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 *	*42 UNITS required; may need 5 subjects*	*No more than TWO from the first group*
*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** 2.798J)**	22.11; 22.12; 22.13; 22.14; 22.15; 22.51; 22.55J	8.591J; 8.592J; 8.593J
2.183J; 2.372J; 2.75J; (2.782J **or** 2.785J **or** 2.79J **or** 3.963J); 2.799; HST.537J		8.311; 8.321; 8.322; 8.333; 8.334; 8.351J; 8.421; 8.422; 8.511; 8.512; 8.613J; 8.701

8.14.2018

Aeronautics and Astronautics

2.080J Structural Mechanics
2.183 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
16.422 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
16.910J Introduction to Numerical Simulation **OR** 16.920J Numerical Methods for Partial Differential
      Equations
22.55J Radiation Biophysics
HST.582J Biomedical Signal and Image Processing

Biological Engineering

You must choose both 20.420 and 20.440.
20.420 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 Foundations of Computational & Systems Biology
Other approved subjects:
20.203J Neurotechnology in Action
20.207 Biotechnologies in Infectious Disease
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
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:
9.012 Cognitive Science
9.013J Molecular and Cellular Neuroscience Core II
9.015J Molecular and Cellular Neuroscience Core I
Other approved subjects:
9.014 Quantitative Methods and Computational Models in Neurosciences
9.021J Cellular Neurophysiology and Computing
9.073J Statistics for Neuroscience Research
9.160 Cellular & Synaptic Neurophysiology
9.181J Developmental Neurobiology

9.285J Audition: Neural Mechanisms, Perception and Cognition
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.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
5.56 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 I (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
6.872J 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
6.831 User Interface Design and Implementation **OR** 6.839 Advanced Computer Graphics
6.832 Underactuated Robotics
HST.508 Evolutionary Genomics
Biophysics 205 (formerly HST.509) Computational and Functional Genomics

[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
6.341   Discrete-Time Signal Processing **OR** 6.344 Digital Image Processing **OR** 6.555J Biomedical
        Signal and Image Processing
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
6.336J Introduction to Numerical Simulation **OR** 6.339J Numerical Methods for Partial Differential
    Equations

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 Biomaterials 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