Biomedical Engineering Graduate Concentrations

Bioelectrics and Neural Engineering: Bioelectricity is the study of electrical fields and potentials within the body. In the bioelectrical concentration students learn how to examine and control these fields towards developing medical devices and restorative therapies. The core classes within this concentration focus on 1) examining nerve and cardiac bioelectrical fields from a computational standpoint and 2) understanding techniques to model neurons and to stimulate and record from individual and large populations of neurons. Electives within this concentration include courses on medical imaging, systems-level neuroscience, and introductions to microelectronics and signal processing. Students graduating from BME with a bioelectrical concentration will be able to work as engineers in the rapidly expanding fields of neural engineering, medical diagnostics, and medical systems industries, or pursue advanced degrees in medicine, basic medical sciences, or bioelectrical engineering. Advisor: Prof. Enrico Opri

Biomaterials and Regenerative Medicine: Biomaterials is the study of interactions between living and non-living materials. Students trained in biomaterials must have a thorough understanding of the materials they work with and properties of the biological system they seek to replace or regenerate. Biomaterials are also an integral component in tissue engineering and regenerative medicine. Biomaterials research areas include: design of orthopaedic, dental, cardiovascular and neuro-sensory prostheses, artificial organs, blood-surface interactions, cellular and tissue engineering, drug delivery, biosensors, microencapsulation technology, and implant retrieval analysis. Students graduating from BME with a concentration in biomaterials will be capable of working in the medical device, tissue engineering or pharmaceutical industries, academic or government laboratories, or pursuing further education in Ph.D. or professional programs. Advisor: Prof. David Kohn

Biomechanics and Biotransport: Biomechanics is a hybrid discipline requiring a thorough understanding of classic engineering mechanics, physiology and cell biology, and the interface between the two. Biomechanics also has important applications in cutting-edge fields like tissue engineering and mechanotransduction. In tissue engineering, one tries to regenerate new tissues to replace defects in existing tissue. This requires knowledge of tissue-mechanical function. Mechanotransduction is the study of how cells sense and react to mechanical stimulus, a field with applications in such diverse areas as hearing (haircell movement in fluids) and orthopaedics (bone and tendon response to physical stress). Graduates in this concentration will be prepared for a wide range of industries concerned with mechanical effects on the human body including surgical device industries, automotive safety, and biotech industries concerned with mechanically functional tissue. Students will also have excellent preparation to attend medical school or pursue a Ph.D. Advisor: Prof. David Kohn

Biomedical Imaging and Ultrasonics: Since the invention of x-ray computerized tomography more than 25 years ago, imaging has become the primary noninvasive diagnostic tool available to the clinician. Although many principles are common to all imaging modalities, biomedical imaging scientists and engineers must understand the basic physics and operating principles of all primary modalities including magnetic resonance imaging (MRI), radiography and nuclear medicine, optics, and ultrasound. Major biomedical imaging companies require such multi-modality expertise to design new devices and procedures. In addition, clinical problems increasingly require the techniques of cell and molecular biology to design both new contrast agents and imaging methods for a wider range of applications. The biomedical imaging curriculum recognizes trends and requires students to have a solid background in signal processing and imaging science, and simultaneously be literate in both the basic life sciences and the basic operating principles of several imaging modalities. Graduates of this program will be well prepared to work in the medical imaging industry, to attend medical school, or to study for a Ph.D. in BME. Advisor: Prof. Xueding Wang

Biotechnology and Systems Biology: Advances in cellular and molecular biology have changed and expanded the ways therapeutic devices and drugs are designed. Modern biotechnology depends on scientists and engineers who study the fundamental properties of cell, molecular, and tissue biology, and apply these to engineer materials and technology to interact with living systems. Goals include production of improved biomaterials for medical implants and prosthetics, tissues engineered for specific functionality, and new therapeutic drugs. The biotechnology
curriculum emphasizes critical areas of chemistry, molecular biology, and cell biology, but also exposes students to a broad range of engineering approaches necessary for this interdisciplinary field. Graduates of this program will be well prepared for jobs in the pharmaceutical or medical device industries, to attend professional schools, or to study for a Ph.D. Advisor: Prof. Paul Jensen

SCHEMATIC OF COMPONENTS OF THE MASTERS COURSE CURRICULUM:

<table>
<thead>
<tr>
<th>Seminar and RCR</th>
<th>Life Sciences</th>
<th>Common to all concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 courses (seminars)</td>
<td>1 course</td>
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</table>

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Statistics</th>
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<tbody>
<tr>
<td>1 course</td>
<td>1 course</td>
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</table>

<table>
<thead>
<tr>
<th>Concentration Core</th>
<th>Experiential</th>
<th>Dependent on concentration and student interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 course → depth</td>
<td>1-2 courses → hands-on</td>
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</table>

<table>
<thead>
<tr>
<th>Technical Electives</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>3-4 courses → depth &amp; breadth</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1: General components of Masters curriculum in Biomedical Engineering.

CONCENTRATION CORE:

**Bioelectrics and Neural Engineering (at least one course):**
- BIOMEDE 417 Electrical Biophysics (4) (I)
- BIOMEDE 517 Neural Engineering (3) (II)

*NOTE:* Students who have previously taken an undergraduate bioelectricity course are advised to take BIOMEDE 517 instead of BIOMEDE 417.

**Biomaterials and Regenerative Medicine:**
- BIOMEDE 410 Design and Applications of Biomaterials (3) (I,II)

**Biomedical Imaging and Ultrasonics:**
- BIOMEDE 516 Medical Imaging Systems (3) (I)

**Biomechanics and Biotransport (at least one course):**
- BIOMEDE 456 Tissue Mechanics (3) (I)
- BIOMEDE 476 Biofluid Mechanics (4) (II)

**Biotechnology and Systems Biology (at least one course):**
- BIOMEDE 504 Cellular Biotechnology (3) (II)
- BIOMEDE 514 Systems Biology of Human Diseases (3) (I)
- BIOMEDE 584 Advances in Tissue Engineering (3) (II) – offered in odd years
EXPERIENTIAL COMPONENT (at least one course):

Students without a prior, approved bioinstrumentation course must take one of:
- BIOMEDE 458 Biomedical Instrumentation and Design (4) (I,II)
- IOE 432 Industrial Engineering Instrumentation Methods (3) (I)
- BIOMEDE 510 Medical Imaging Laboratory (3) (II)

Students with a prior bioinstrumentation course can take an additional bioinstrumentation course from the list above, or one of the following experiential courses:
- BIOMEDE 590\(^1\) Directed Research (2-6) (I,II,III,IIIa,IIIb)
- BIOLCHEM 516 Introductory Biochemistry Laboratory (3) (I,II)
- MCDB 429 Laboratory in Cell and Molecular Biology (3) (II)

NOTES:  \(^1\) Students can count up to 6 letter-graded credits of BIOMEDE 590 toward the MS degree. Students who count 4 or more credits, either in a single or multiple terms, are required to complete a MS Thesis and defense. PhD students can also count the MS Thesis and defense as the BME Qualifying Examination.

SEMINAR AND RESPONSIBLE CONDUCT OF RESEARCH (both courses are required):
- BIOMEDE 500 Biomedical Engineering Seminar (1) (I,II)
- BIOMEDE 550 Ethics and Enterprise (1) (I)

NOTES: Recommended to be taken in first term or year of study. BIOMEDE 550 satisfies UM Responsible Conduct of Research and Scholarship (RCRS) requirement.

MATHEMATICS (choose one course):

Courses recommended for BME students:
- MATH 450 Advanced Mathematics for Engineers I (4) (I,II)
- MATH 454 Boundary Value Problems for Partial Differential Equations (3) (I,II,IIIa)
- MATH 463 Mathematical Modeling in Biology (3) (I)

Course recommended for BME students following the Biomedical Imaging and Ultrasonics concentration:
- EECS 453 Principles of Machine Learning (4) (I)
- EECS 551\(^1\) Matrix Methods for Signal Processing (4) (I)
- EECS 553\(^2\) Machine Learning (ECE) (3) (I)

NOTES: \(^1\) EECS 551 similar to the content in EECS 505 which is no longer offered.
\(^2\) This is a difficult course geared towards Machine Learning, with emphasis on mathematical derivations and principles. If you take this course, you cannot take EECS 545 due to content overlap.

Other courses with specialized content:
- MATH 462 Mathematical Models (3) (II)
- MATH 471 Introduction to Numerical Methods (3) (I,II,IIIb)
- MATH 540 Mathematics of Biological Networks (3) (I)
- MATH 550 Introduction to Adaptive Systems (3) (I)
- MATH 555 Introduction to Functions of a Complex Variable with Applications (3) (I,II)
- MATH 556 Applied Functional Analysis (3) (I)
MATH 557  Applied Asymptotic Analysis (3) (II)
MATH 558  Applied Nonlinear Dynamics (3) (I)
MATH 559  Topics in Applied Mathematics (3) (varies)
MATH 561  Linear Programming I (3) (I,II)
MATH 562  Continuous Optimization Methods (3) (II)
MATH 563  Advanced Mathematical Methods for the Biological Sciences (3) (II)
MATH 564  Topics in Mathematical Biology (3) (II)
MATH 568  Mathematical and Computational Neuroscience (3) (I)
MATH 571  Numerical Linear Algebra (3) (I,II)
MATH 572  Numerical Methods for Differential Equations (3) (II)
MATH 651  Topics in Applied Mathematics: Modeling and Mechanics (3) (I)
MATH 656  Introduction to Partial and Differential Equations (3) (I)
MATH 657  Nonlinear Partial Differential Equations (3) (II)
MATH 756  Advanced Topics in Partial Differential Equations (3) (II)
MECHENG 501  Mathematical Methods in Mechanical Engineering (3) (I)
MECHENG 564  Linear Systems Theory (4) (I,II)
ROB 501  Math for Robotics (4) (I)

STATISTICS (choose one course):

Course recommended for BME students:
BIOMEDE 503  Statistical Methods for Biomedical Engineering (3) (II)

Other courses with specialized content:
BIOSTAT 602  Biostatistical Inference (4) (II)
BIOSTAT 650  Applied Statistics I: Linear Regression (4) (I)
BIOSTAT 651  Applied Statistics II: Extensions for Linear Regression (3) (II)
EECS 501  Probability and Random Processes (4) (I,II)
IOE 461  Quality Engineering Principles and Analysis (3) (I)
IOE 465  Design of Experiment (3) (II)
IOE 466  Statistical Quality Control (3) (I,II)
STATS 470  Introduction to the Design of Experiments (4) (I)
STATS 500  Statistical Learning I: Regression (3) (I)
STATS 513  Regression and Data Analysis (3) (II)
STATS 525  Probability Theory (3) (I)

NOTE: BME graduate students can only take EECS 501 in the winter term.

LIFE SCIENCES (choose one course):

Courses recommended for BME students:
BIOMEDE 514  Systems Biology of Human Diseases (3) (I)
BIOMEDE 519  Quantitative Physiology (4) (I) (II)
BIOLCHEM 515  Introductory Biochemistry (3) (I,II)
CDB 530  Cell Biology (3) (I)
CDB 550  Histology (4) (II)

Other courses with specialized content:
ANATOMY 403  Human Anatomy: Structure and Function (5) (I,II)
ANATOMY 503  1Human Anatomical Dissection Lab (3) (I)
ANATOMY 541  Mammalian Reproductive Physiology (4) (II)
BIOLCHEM 451  Advanced Biochemistry: Macromolecular Structure and Function (4) (I)
BIOPHYS 520  Methods of Biophysical Chemistry (3) (I)
CANCBIOL 554  The Science of Cancer (4) (II)
CD B 581  Development Genetics (3) (I)
CD B 583  Organogenesis: Stem Cells to Regenerative Biology (3) (II)
KINESLGY 522  Clinical Neurophysiology and Neuroimaging (3) (varies)
KINESLGY 545  Metabolic Responses to Exercise (3) (II)
MCDB 422  Brain Development, Plasticity, and Circuits (3) (II)
MCDB 423  Introduction to Research in Cellular and Molecular Neurobiology (3) (I,II)
MCDB 427  Molecular Biology (4) (I,II)
MCDB 428  Cell Biology (4) (I,II)
MCDB 435  Intracellular Trafficking (3) (II)
MICRBIOL 540  Human Immunology (3) (II)
MICRBIOL 640  Molecular and Cellular Immunology (3) (I)
NEUROSCI 570  Human Neuroanatomy I (3) (I)
NEUROSCI 601  Principles of Neuroscience I (3) (I)
NEUROSCI 602  Principles of Neuroscience II (3) (II)
PATH 581  Tissue, Cellular and Molecular Disease (3) (II)
PHYSIOL 520  Computational Systems Biology in Physiology (3) (II)
PHYSIOL 592  Integrated Neuroscience (2-4) (II)

NOTES: 1 ANATOMY 503 is a lab course designed as a next step for students who have completed ANATOMY 403 or an equivalent anatomy course with a lab. Students who are interested in taking this class should contact the instructor for approval.

TECHNICAL ELECTIVES:
Students must take sufficient technical elective credits to reach at least the 30 credits overall required for the MS degree. No more than 2 credits of seminar courses may be applied to the MS degree.

NOTE: Students in any concentration may take one technical elective from the Professional Development list of technical electives (see Pages 7 and 8).

Bioelectrics and Neural Engineering
BIOMEDE 510  Medical Imaging Laboratory (3) (II)
BIOMEDE 516  Medical Imaging Systems (3) (I)
BIOMEDE 517 1 Neural Engineering (3) (II)
BIOMEDE 527  Current Topics in Neuromodulation (3) (I)
BIOMEDE 599.016  Applied Neural Control (3) (II)
EECS 414  Introduction to MEMS (4) (I)
EECS 425  Integrated Microsystems Laboratory (4) (II)
EECS 427 2 VLSI Design I (4) (I,II)
EECS 522 2 Analog Integrated Circuits (4) (II)
EECS 545 2,3,4 Machine Learning (3) (I,II)
EECS 553 2,3,4 Machine Learning (3) (I,II)
EECS 564 2,3 Estimation, Filtering, and Detection (3) (II)
HS 650  Data Science and Predictive Analytics (4) (I)
NEUROSCI 613  Circuits and Computational Neuroscience (1) (I)
NEUROSCI 614  Sensory and Systems Neuroscience (1) (II)
NEUROSCI 615  Cognitive and Behavioral Neuroscience (1) (II)
NOTES:  
1. Can be taken as an elective if BIOMEDE 417 is taken as the concentration core.
2. EECS courses are challenging without an appropriate background. Students are recommended to verify prerequisites and contact course instructors prior to registration.
3. Must take EECS 501/551 prerequisite, which also covers the STATISTICS component.
4. You cannot take both EECS 545 and EECS 553 due to content overlap.

**Biomaterials and Regenerative Medicine**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Session(s)</th>
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<tr>
<td>BIOMEDE 418</td>
<td>Quantitative Cell Biology (3) (I,II)</td>
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<tr>
<td>BIOMEDE 456</td>
<td>Tissue Mechanics (3) (I)</td>
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<tr>
<td>BIOMEDE 474</td>
<td>Introduction to Tissue Engineering (3) (I) – for SUGS and Master’s students only</td>
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<tr>
<td>BIOMEDE 476</td>
<td>Biofluid Mechanics (4) (II)</td>
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<tr>
<td>BIOMEDE 479</td>
<td>Biotransport (4) (II)</td>
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<tr>
<td>BIOMEDE 514</td>
<td>Systems Biology of Human Diseases (3) (I)</td>
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<tr>
<td>BIOMEDE 561</td>
<td>Biological Micro- and Nanotechnology (3) (II)</td>
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<tr>
<td>BIOMEDE 563</td>
<td>Biomolecular Engineering of Interfaces (3) (II)</td>
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<tr>
<td>BIOMEDE 584</td>
<td>Advances in Tissue Engineering (3) (II) – offered in odd years</td>
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<tr>
<td>BIOMEDE 599.015</td>
<td>Mechanobiology (2) (I)</td>
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<td>BIOMEDE 599.018</td>
<td>Immunoengineering (3) (I)</td>
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<tr>
<td>HS 650</td>
<td>Data Science and Predictive Analytics (4) (I)</td>
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<tr>
<td>MATSCIE 412</td>
<td>Polymeric Materials (3) (I)</td>
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<tr>
<td>MATSCIE 420</td>
<td>Mechanical Behavior of Materials (3) (I)</td>
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<tr>
<td>MATSCIE 440</td>
<td>Ceramic Materials (3) (II)</td>
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<tr>
<td>MATSCIE 465</td>
<td>Structural and Chemical Characterization of Materials (3) (I,II)</td>
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<tr>
<td>MATSCIE 512</td>
<td>Physical Polymers (3) (II)</td>
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<tr>
<td>MATSCIE 514</td>
<td>Composite Materials (3) (II)</td>
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<td>MATSCIE 515</td>
<td>Mechanical Behavior of Solid Polymeric Materials (3) (II)</td>
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<td>MATSCIE 517</td>
<td>Advanced Functional Polymers: Molecular Design and Applications (3) (I)</td>
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<td>MATSCIE 560</td>
<td>Structure of Materials (3) (I)</td>
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<tr>
<td>MATSCIE 562</td>
<td>Electron Microscopy I (4) (II)</td>
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<tr>
<td>MATSCIE 577</td>
<td>Failure Analysis of Materials (3) (II)</td>
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<tr>
<td>MATSCIE 593.076</td>
<td>Advanced Biomaterials (3) (II)</td>
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**Biomedical Imaging and Ultrasonics**

<table>
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<th>Course Title</th>
<th>Credits</th>
<th>Session(s)</th>
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<tbody>
<tr>
<td>BIOMEDE 510</td>
<td>Medical Imaging Laboratory (3) (II) (Strongly recommended)</td>
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<tr>
<td>BIOMEDE 417</td>
<td>Electrical Biophysics (4) (I)</td>
<td></td>
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<tr>
<td>BIOMEDE 418</td>
<td>Quantitative Cell Biology (4) (I,II)</td>
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<tr>
<td>BIOMEDE 442</td>
<td>Introduction to Biomedical Imaging (3) (I)</td>
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<tr>
<td>BIOMEDE 599.019</td>
<td>Machine Learning for Biomedical Signal &amp; Image Processing (3) (II)</td>
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<tr>
<td>BIOMEDE 599.020</td>
<td>Advanced Topics in MRI (3) (I)</td>
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<tr>
<td>EECS 556</td>
<td>Image Processing (3) (II)</td>
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**Biomechanics and Biotransport**

Technical electives with fluid mechanics content:

<table>
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<th>Credits</th>
<th>Session(s)</th>
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<tr>
<td>BIOMEDE 479</td>
<td>Biotransport (4) (II)</td>
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<tr>
<td>AEROSP 521</td>
<td>Experimental Methods in Fluid Mechanics (3) (II)</td>
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<tr>
<td>CHE 527</td>
<td>Fluid Flow (3) (I)</td>
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<tr>
<td>CHE 542</td>
<td>Intermediate Transport Phenomena (3) (II)</td>
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<tr>
<td>MECHENG 520</td>
<td>Advanced Fluid Mechanics I (3) (I)</td>
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<tr>
<td>MECHENG 523</td>
<td>Computational Fluid Dynamics I (3) (I)</td>
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<tr>
<td>MECHENG 524</td>
<td>Advanced Engineering Acoustics (3) (I)</td>
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<tr>
<td>MECHENG 530</td>
<td>Advanced Heat Transfer (3) (II)</td>
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</tbody>
</table>
MECHENG 617  Mechanics of Polymers II (3) (II)

Technical electives with biomechanics content:
  BIOMEDE 534  Occupational Biomechanics (3) (II)
  MECHENG 599.006  Cellular Engineering (3) (II)

Technical Electives with Connective Tissue Content:
  BIOMEDE 410  Design and Applications of Biomaterials (3) (I,II)
  BIOMEDE 599.015  Mechanobiology (2) (I)
  HS 650  Data Science and Predictive Analytics (4) (I)
  MECHENG 505  Finite Element Methods in Mechanical Engineering & Applied Mechanics (3) (I)
  MECHENG 511  Solid Continua (3) (I)
  MECHENG 512  Theory of Elasticity (3) (II)
  MECHENG 517  Mechanics of Polymers I (3) (II)

Technical Electives with Dynamics/Control Content:
  EECS 562  Nonlinear Systems & Control (3) (II)
  MECHENG 440  Intermediate Dynamics & Vibrations (4) (II)
  MECHENG 540  Intermediate Dynamics (3) (I)
  MECHENG 543  Analytical & Computational Dynamics I (3) (II)
  MECHENG 560  Modeling Dynamic Systems (3) (I)
  MECHENG 561  Design of Digital Control Systems (3) (II)

Biotechnology and Systems Biology
  BIOMEDE 410  Design and Applications of Biomaterials (3) (I,II)
  BIOMEDE 456  Tissue Mechanics (3) (I)
  BIOMEDE 476  Biofluid Mechanics (4) (II)
  BIOMEDE 479  Biotransport (4) (II)
  BIOMEDE 504  Cellular Biotechnology (3) (II)
  BIOMEDE 514  Systems Biology of Human Diseases (3) (I)
  BIOMEDE 561  Biological Micro- and Nanotechnology (3) (II)
  BIOMEDE 599.011  Engineering Approaches to Cancer Biology (3) (II)

  BIOINF 527  Introduction to Bioinformatics and Computational Biology (4) (I)
  BOLCHEM 660  Molecules of Life: Protein Structure, Function and Dynamics (3) (I)
  CANCBIO 554  The Science of Cancer (4) (II)
  CDB 550  Histology (4) (II)
  CHE 519  Pharmaceutical Engineering (3) (II)
  CHE 528  Reactor Engineering (3) (II)
  CHE 538  Statistical and Irreversible Thermodynamics (3) (I)
  CHE 542  Intermediate Transport Phenomena (3) (II)
  CHE 696  Selected Topics (3) (I,II)
  EECS 414  Introduction to MEMS (4) (I)
  HS 650  Data Science and Predictive Analytics (4) (I)
  MATSCIE 593.076  Advanced Biomaterials (3) (II)
  MCDB 611  Neurochemistry/Neuropharmacology (1) (I)
  MECHENG 553  Microelectromechanical Systems (3) (I)
  MECHENG 599.006  Cellular Engineering (3) (II)
Professional Development

*NOTE:* Students in *any concentration* may take *one class* from the following list as a technical elective.

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name and Credits (Term)</th>
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<tbody>
<tr>
<td>BIOMEDE 499.002</td>
<td>Clinical Observation and Needs Finding (2) (I)</td>
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<tr>
<td>BIOMEDE 504</td>
<td>Cellular Biotechnology (3) (II)</td>
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<tr>
<td>BIOMEDE 523</td>
<td>Business of Biology (2.25) (I)</td>
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<td>ARTDES 652</td>
<td>Design in the 21st Century</td>
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<td>BA523</td>
<td>Comprehensive Healthcare Strategies</td>
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<td>BE 608</td>
<td>Health Care Markets and Public Policies (1.5) (I)</td>
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<td>BIOINF 622</td>
<td>Translational Research (2) (I)</td>
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<tr>
<td>CHE 517</td>
<td>Biopharmaceutical Engineering (3) (II)</td>
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<tr>
<td>ENTR 500</td>
<td>An Introduction to Innovation: Tools for Career Success (3) (I)</td>
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<tr>
<td>ENTR 520</td>
<td>Technology-Inspired Business Models (3) (I)</td>
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<td>ENTR 530</td>
<td>Innovation &amp; IP Strategy (3) (I)</td>
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<tr>
<td>ENTR 540</td>
<td>Business Math for Innovators (1.5) (II)</td>
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<tr>
<td>ENTR 550</td>
<td>Interpersonal Skills: Leveling Up to Leadership (3) (I)</td>
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<tr>
<td>ENTR 560</td>
<td>Project Management and Consulting (3) (I,II)</td>
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<tr>
<td>ES 512</td>
<td>Business Basics for Graduate Engineers (3) (II)</td>
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<tr>
<td>ES 720</td>
<td>Commercialization of Biomedicine (1.5) (II)</td>
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<tr>
<td>HS 650</td>
<td>Data Science and Predictive Analytics (4) (I)</td>
</tr>
<tr>
<td>IOE 461</td>
<td>Quality Engineering Principles</td>
</tr>
<tr>
<td>IOE 491.083</td>
<td>Leadership in the Digital Age (2) (I)</td>
</tr>
<tr>
<td>IOE 548</td>
<td>Integrated Product Development (3) (I)</td>
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<tr>
<td>IOE 561</td>
<td>Risk Analysis</td>
</tr>
<tr>
<td>IOE 570</td>
<td>Design of Experiments</td>
</tr>
<tr>
<td>ISD 527</td>
<td>Designing in Quality: A Design for Six Sigma (3) (II)</td>
</tr>
<tr>
<td>MECHENG 599.003</td>
<td>Additive Manufacturing Theory and Practice (3) (II)</td>
</tr>
</tbody>
</table>

**KEY AND ADDITIONAL NOTES:**

Course Department & Number  Course Name (# of credits) (term offered)

Terms:  I - fall, II - winter, III - spring-summer, IIIa - spring half, IIIb - summer half

Students are responsible for checking the Office of the Registrar’s [Schedule of Classes](#) to ensure that their selected courses are offered and fit their schedule.

Courses with 499/599 designation are in pilot phase and may not be offered in the term indicated.