Biomedical Engineering Graduate Concentration – Fall 2015
Biomaterials
Advisor: David Kohn, Ph.D.

BIOMATERIALS:
BIOMEDE 410 Design and Applications of Biomaterials (3) (I)

GENERAL (both courses are required):
BIOMEDE 500 Biomedical Engineering Seminar (1) (I,II)
BIOMEDE 550 Ethics and Enterprise (1) (I)

BIOMEDICAL RESEARCH AND DESIGN (select one – BIOMEDE 590 or BIOMEDE 599.002 and BIOMEDE 599.004):
BIOMEDE 590 Directed Research (2 - 3) (I,II,III)
BIOMEDE 599.002 Graduate BME Innovative Design Team (3) (I)
BIOMEDE 599.004 Graduate BME Innovative Design Team (4) (II)

NOTE: In order for BIOMEDE 599.002 and BIOMEDE 599.004 to count toward their degree in BME, students must register for these courses in both the fall and winter terms, and they must adhere to the following rules:

a) this course can be counted as a SUGS, terminal MS, or MS/PhD student's 2 credit hour technical elective (fall term) and Biomedical Research and Design requirement (winter term),
b) this course, taken in both terms, can be counted as a technical elective for a student that has already taken BIOMEDE 590,
c) this course can be counted as PhD coursework providing that it has not already been counted as the student's Biomedical Research and Design requirement or technical elective in their MS program, and the student's advisor approves.

MATHEMATICS (select one course):
MATH 450 Advanced Mathematics for Engineers I (4) (I,II,IIIb)
MATH 454 Boundary Value Problems for Partial Differential Equations (3) (I,II,IIIa)
MATH 462 Mathematical Models (3) (II)
MATH 463 Mathematical Modeling in Biology (3) (I)
MATH 471 Introduction to Numerical Methods (3) (I,II,IIIb)
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)
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 Math Biology (3)
MATH 571 Numerical Linear Algebra (3) (I,II)
MATH 572 Numerical Methods for Differential Equations (3) (II)
MATH 651 Topics in Applied Mathematics I (3) (I,II)
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)
MECHENG 501 Math Methods in Mechanics (3) (II)
MECHENG 564 Linear Systems Theory (4) (I)

BIOINSTRUMENTATION (select one course):
BIOLCHEM 516 Intro Biochemistry Lab (3) (I)
BIOMEDE 458    Biomedical Instrumentation and Design (4) (I, II)
BIOMEDE 510    Medical Imaging Laboratory (3) (II)
IOE 432        Industrial Engineering Instrumentation Methods (3) (I)
MCDB 429       Cellular & Molecular Biology Lab (3) (II)

STATISTICS (select one course):
BIOMEDE 503    Statistical Methods for Biomedical Engineering (3) (II)
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)
STATS 470      Introduction to the Design of Experiments (4) (I)
STATS 500      Applied Statistics I (3) (I)
STATS 525      Probability Theory (3) (I)

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

LIFE SCIENCE (two courses are required – at least one course must be outside of the College of Engineering):

Required:
BIOMEDE 519    Quantitative Physiology (4) (I)

Select one course:
ANAT 403       Human Anatomy (5) (I,II)
ANAT 541       Mammal Reprod (4) (II)
BIOCHEM 451    Introductory Biochemistry I (4) (I)
BIOCHEM 515    Introductory Biochemistry (3) (I, II)
BIOCHEM 550    Macromol Struc & Func (3) (I)
BIOPHYS 520    Biophys Chem I (3) (I)
CANCBIOL 553   Cancer Biol (2) (I)
CDB 530        Cell Biology (3) (I)
CDB 550        Histology (4) (II)
CDB 581        Developmental Genetics (3) (I)
CDB 583        Stem Cells Regen Bio (3) (II)
KINESLGY 522   Clin Neurophys Image (3) (II)
KINESLGY 545   Metab Respon to Exer (3) (II)
MCDB 422       Cellular and Molecular Neurobiology (3) (I)
MCDB 423       Neurology Lab (3) (I)
MCDB 427       Molecular Biology (4) (I)
MCDB 428       Cell Biology (4) (II)
MCDB 429       Laboratory in Cell and Molecular Biology (3) (II)
MCDB 435       Intracellular Trafficking (3) (I)
MCDB 530       Cell Biology (3) (I)
MICROBIOL 440  Immunology (3) (II)
NEUROSCI 570   Human Neuroanatomy (3) (I)
NEUROSCI 601   Principles Neuro I (4) (I)
NEUROSCI 602   Principles Neuro II (4) (II)
PATH 581       Tissue, Cellular and Molecular Basis of Disease (4) (II)
PHYSIOL 592    Integrative Neuroscience (3) (II)
PHYSIOL 600    Pathophysiology (3) (II)

TECHNICAL ELECTIVES:
4-8 hours of graduate level engineering or life science courses (technical electives). No more than 2 credit hours of seminar courses may be applied to the 30 credit hours needed to fulfill the MS degree requirement.
Examples of Technical Electives Applicable to Biomaterials Option:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
<th>Term</th>
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<tbody>
<tr>
<td>BIOMEDE 418</td>
<td>Quantitative Cell Biology (4) (I,II)</td>
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<td>BIOMEDE 456</td>
<td>Tissue Mechanics (3) (I)</td>
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<td>BIOMEDE 476</td>
<td>Biofluid Mechanics (3) (II)</td>
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<td>BIOMEDE 479</td>
<td>Biotransport (4) (II)</td>
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<td>BIOMEDE 556</td>
<td>Molecular and Cellular Biomechanics (3) (I)</td>
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<td>BIOMEDE 561</td>
<td>Biological Micro-and Nanotechnology (3) (I)</td>
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<td>BIOMEDE 563</td>
<td>Biomolecular Engineering of Interfaces (3) (II)</td>
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<td>BIOMEDE 584</td>
<td>Tissue Engineering (3) (II)</td>
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<td>BIOMEDE 594</td>
<td>Recent Advances in the Polymer Therapeutics (3) (I)</td>
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<td>BIOMEDE 616</td>
<td>Analysis of Chemical Signaling (3) (II)</td>
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<td>CDB 550</td>
<td>Through the Looking Glass – From Stem Cells to Tissues and Organs (4) (II)</td>
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<td>ES 512</td>
<td>Business Basics for Graduate Engineers (3) (II)</td>
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<td>MECHENG 599.002</td>
<td>Cellular Engineering (3) (I)</td>
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<td>PHARMSCI 763</td>
<td>Cellular &amp; Molecular Approaches to Drug Delivery (2)</td>
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Examples of Other Courses Applicable to Biomaterials:

Advanced Materials:

- Ceramics: MATSCIE 440, 542, 543, 544
- Polymers: MATSCIE 412, 414, 511, 512, 515
- Composites: MATSCIE 514; AE 515, 516

Mechanisms:

- Mechanical and Physical Aspects of Biomaterials:
  MATSCIE 420, 430, 520, 532, 535, 560, 577; MECHENG 412, 505, 512, 514, 517, 519, 605

- Surface and Biological Aspects of Biomaterials:
  MATSCIE 465, 505, 517, 562, 662; CHE 470, 519

Sample Course Sequences for Biomaterials Option in Biomedical Engineering:

Foci in biomaterials may be developed in several ways. For example:

1) Materials (i.e., metals, ceramics, polymers, composites)
2) Mechanisms (i.e., mechanical, physical, surface science)
3) Application (i.e., materials for hard tissue, soft tissue, blood contact, biosensors, controlled release)

Example I - Focus on Mechanical/Physical Aspects of Biomaterials:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Fall</td>
<td>BIOMEDE 410, BIOMEDE 458, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550</td>
</tr>
<tr>
<td>Winter</td>
<td>BIOMEDE 590, BIOMEDE 503, MATH 463, MATSCIE 414</td>
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<tr>
<td>Fall</td>
<td>BIOMEDE 456, MCDB 427, MECHENG 505 or CHE 470</td>
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Example II - Focus on Biopolymers:

<table>
<thead>
<tr>
<th>Term</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Fall</td>
<td>BIOMEDE 410, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550, MATSCIE 511</td>
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<tr>
<td>Winter</td>
<td>MCDB 429, Technical Elective, BIOMEDE 503</td>
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<tr>
<td>Fall</td>
<td>BIOMEDE 590, MATH 454, MCDB 427</td>
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Example III - Focus on Cell/Surface Aspects of Biomaterials:

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<thead>
<tr>
<th>Term</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>BIOMEDE 410, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550, MCDB 427</td>
</tr>
<tr>
<td>Winter</td>
<td>MCDB 429, Technical Elective, BIOMEDE 503</td>
</tr>
<tr>
<td>Fall</td>
<td>MATH 454, Bioinstrumentation, BIOMEDE 590</td>
</tr>
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**KEY AND ADDITIONAL NOTES:**

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

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

Every effort is made to make sure that the course offering is correct, but students should refer to the Schedule of Classes or the department’s website for the current offering.