Biomedical Engineering Graduate Concentration – Fall 2016
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 in Biology (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)
MATH 656 Introduction to Partial and Differential Equations (3) (I)
MATH 657 Nonlinear Partial Differential Equations (3)
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  Mammalian Reproductive Physiology (4) (II)
BIOLCHEM 451  Advanced Biochemistry I (4) (I)
BIOLCHEM 515  Introductory Biochemistry (3) (I, II)
BIOLCHEM 550  Macromolecular Structure and Function (3) (I)
BIOPHYS 520  Methods of Biophysical Chemistry (3) (I)
CANCBIOL 553  Molecular Biology of Cancer (3) (I)
CANCBIOL 554  Cancer Pathogenesis and Treatment (3) (II)
CDB 530  Cell Biology (3) (I)
CDB 550  Histology (4) (II)
CDB 581  Development Genetics (3) (I)
CDB 583  Organogenesis: Stem Cells to Regenerative Biology (3) (II)
KINESLGY 522  Clinical Neurophysiology and Neuroimaging (3)
KINESLGY 545  Metabolic Responses to Exercise (3)
MCDB 422  Brain Development, Plasticity, and Circuits (3) (I)
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 429  Cellular and Molecular Biology Laboratory (3) (II)
MCDB 435  Intracellular Trafficking (3) (II)
MICROBIOL 440  Human Immunology (3) (II)
NEUROSCI 570  Human Neuroanatomy I (3) (I)
NEUROSCI 601  Principles Neuro I (3) (I)
NEUROSCI 602  Princ Neurosc II (3) (II)
PATH 581  Tissue, Cellular and Molecular Disease (4) (II)
PHYSIOL 592  Integrated Neuroscience (2-4) (II)
TECHNICAL ELECTIVES:
4-8 hours of graduate level engineering or life science courses (technical electives). For students with non-engineering backgrounds it is recommended that engineering courses be taken for 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:
BIOMEDE 418  Quantitative Cell Biology (3) (I,II)
BIOMEDE 456  Tissue Mechanics (3) (I)
BIOMEDE 476  Biofluid Mechanics (4) (II)
BIOMEDE 479  Biotransport (4) (II)
BIOMEDE 563  Biomolecular Engineering of Interfaces (3) (II)
BIOMEDE 584  Advances in Tissue Engineering (3)
CDB 550  Histology (4) (II)
ES 512  Business Basics for Graduate Engineers (3) (II)
MECHENG 599.002  Special Topics in Mechanical Engineering (3) (II)

Examples of Other Courses Applicable to Biomaterials:
Advanced Materials:
Ceramics: MATSCIE 440
Polymers: MATSCIE 412, 512, 515
Composites: MATSCIE 514; AE 516

Mechanisms:
Mechanical and Physical Aspects of Biomaterials:
MATSCIE 420, 520, 532, 535, 560, 577; MECHENG 412, 505, 512, 517, 519
Surface and Biological Aspects of Biomaterials:
MATSCIE 465, 517, 562; CHE 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:
Fall  BIOMEDE 410, BIOMEDE 458, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550
Winter BIOMEDE 590, BIOMEDE 503, MATH 463, Technical Elective
Fall  BIOMEDE 456, MCDB 427, MECHENG 505 or CHE 548

Example II - Focus on Biopolymers:
Fall  BIOMEDE 410, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550, Technical Elective
Winter MCDB 429, Technical Elective, BIOMEDE 503
Fall  BIOMEDE 590, MATH 454, MCDB 427

Example III - Focus on Cell/Surface Aspects of Biomaterials:
Fall  BIOMEDE 410, BIOMEDE 500, BIOMEDE 519, BIOMEDE 550, MCDB 427
Winter MCDB 429, BIOMEDE 584, BIOMEDE 503
Fall  MATH 454, Technical Elective, BIOMEDE 590

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

If a term is not listed after the course, please contact the department for course offering information.

Every effort is made to make sure that the course offering information listed on the concentration is correct. Students can also refer to the Schedule of Classes or the department for the current offering.