

## **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 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)

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)
CANCBIO 553	Molecular Biology of Cancer (3) (I)
CANCBIO 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)
MICRBIOL 540	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.