

BIOMED E BIOMATERIALS CONCENTRATION - F07

MS: 30 total credit hours minimum

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Biomaterials:

BIOMED E 410 Design and Applications of Biomaterials (4) (I)¹

ME 504 Principles and Applications of Variational Methods (3) (I)

Microbiol 510 Mathematical Modeling of Infectious Diseases (3) (I)

General:

BIOMED E 500 Biomedical Engineering Seminar (1) (I,II)

BIOMED E 550 Ethics and Enterprise (1) (I)

Bioinstrumentation (one course, either electrically, chemically or biologically based, from the following):

Biol Chem 516 Intro Biochemistry Lab (3) (I)

MCDB 429 Lab in Cellular & Molecular Biology (3) (II)

BIOMED E 458 Biomedical Instrumentation and Design (4) (I,II)

MSE 414 Applied Polymer Processing (3) (II)

MSE 465 Structural and Chemical Characterization of Materials (3) (II)

Biomedical Research and Design (one course):

BIOMED E 450 Biomedical Design (4) (II) – for MS only students

BIOMED E 590 Directed Research (2) (I,II,III)

BIOMED E 599 - Section 001 Graduate BME Innovative Design Team (2) (I) **AND**

BIOMED E 599 - Sections 004 and 005 Graduate BME Innovative Design Team (4) (II)²

Statistics (one course):

Biostats 602 Biostatistical Inference (4) (II)

Biostats 650 Applied Statistics I: Linear Regression (4) (I)

Biostats 651 Applied Statistics II: Extensions for Linear Regression (3) (II)

IOE 465 Design & Analysis of Industrial Experiments (4) (II)

Statistics 470 Introduction to the Design of Experiments (4) (I)

Statistics 500 Applied Statistics I (3) (I)

Statistics 501 Applied Statistics II (3) (II)

Statistics 547 Probabilistic Modeling in Bioinformatics (3) (I)

Mathematics (one course):

BIOMED E 464 Inverse Problems (3) (II)

Math 419 Linear Spaces and Matrix Theory (3) (I,II)

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)³

Math 463 Math Modeling in Biology (3) (I)

Math 550 Introduction to Adaptive Systems (3)³

Math 556 Methods of Applied Math I (3) (I)

Math 557 Methods of Applied Math II (3) (II)

Math 563 Advanced Mathematical Methods for the Biological Sciences (3) (II)

Math 651 Topics in Applied Mathematics I (3)³

Math 656 Introduction to Partial Differential Equations (3)³

ME 501 Analytical Methods in Mechanics (3) (II)

ME 502 Methods of Differential Equations in Mechanics (3) (I)

Life Science (two courses minimum):

Required:

BIOMED E 519 Quantitative Physiology (4) (I)

And one of the following:

Biol Chem 451⁴ Introductory Biochemistry I (4) (I)

Biol Chem 515 Introductory Biochemistry (3) (I)

BIOMED E 401 The Human Body (4) (I)

BIOMED E 418 Quantitative Cell Biology (4) (II)

MCDB 411 Protein Structure and Function (3) (I)

BIOMED E BIOMATERIALS OPTION

MCDB 427 ⁵	Molecular Biology (4) (I)
MCDB 428 ⁵	Cell Biology (4) (II)
MCDB 435 ⁵	Intracellular Trafficking (3) (I)
MCDB 469 ⁵	Signal Transduction (3) (II)
MCDB 530	Cell Biology (3) (I)
Pathology 581 ⁵	Cellular and Molecular Basis of Disease (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:

BIOMED E 456	Tissue Mechanics (3) (I)
BIOMED E 476	Biofluid Mechanics (3) (II)
BIOMED E 479	Biotransport (4) (II)
BIOMED E 556	Molecular and Cellular Biomechanics (3) (I)
BIOMED E 561	Biological Micro- and Nanotechnology (3) (I)
BIOMED E 584	Tissue Engineering (3) (II)
BIOMED E 616	Analysis of Chemical Signaling (3) (II)

Examples of Other Courses Applicable to Biomaterials:

Advanced Materials:

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

Mechanisms:

Mechanical and Physical Aspects of Biomaterials:	MSE 420, 430, 520, 532, 535, 560, 577; ME 412, 505, 512, 514, 517, 519, 605
Surface and Biological Aspects of Biomaterials:	MSE 465, 505, 517, 562, 662; ChemE 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:

Fall	BIOMED E 410, BIOMED E 500, BIOMED E 519, BIOMED E 550, Stats 500
Winter	BIOMED E 458, BIOMED E 590, Math 463, MSE 414
Fall	BIOMED E 456, MCDB 427, ME 505 or ChemE 548

Example II - Focus on Biopolymers:

Fall	BIOMED E 410, BIOMED E 500, BIOMED E 519, BIOMED E 550, Stats 500
Winter	MCDB 429, BIOMED E 584, BIOMED E 590
Fall	Math 454, MCDB 427, MSE 511

Example III - Focus on Cell/Surface Aspects of Biomaterials:

Fall	BIOMED E 410, BIOMED E 500, BIOMED E 519, BIOMED E 550, Stats 500
Winter	MCDB 429, BIOMED E 584, MSE 562
Fall	MCDB 427, Math 454, BIOMED E 590

¹ I - fall, II - winter, III - spring-summer, IIIa - spring half, IIIb - summer half.

² In order for this course to count toward their degree in BME, students must register for this course in both the fall and winter terms, and they must adhere to the following rules:

a) this course can be counted as a SGUS, 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 BIOMED E 450 or BIOMED E 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.

³ Refer to the Mathematics department for current offering.

⁴ Students that have received their undergraduate degree at U of M and have taken Biol 310 or 311 will not get credit for taking Biol Chem 451.

⁵ These life courses are not recommended without appropriate prerequisites.