

BIOMEDICAL ENGINEERING DEPARTMENT

MEDICAL ENGINEERING UNDERGRADUATE CURRICULUM

2008-2009 (as of 8/12/08)

Students entering this program are expected to have advanced work in high school such that they can be placed into MATH 230 and CHEM 171, or higher. All courses must be passed with a C grade or higher, and no courses within the 48 required for the degree may be taken P/N without approval.

I. MATHEMATICS (4 courses)

AP placement-Math 220, 224

MATH	230	Calculus
MATH	234	Multiple Integration and Vector Calculus

II. BASIC SCIENCES (4 courses)

PHYSICS	135-2, 3	General Physics
CHEM	171, 172	Accelerated Chemistry

III. ENGINEERING ANALYSIS (4 courses)

GEN ENG	205-1	Computational Methods and Linear Algebra
GEN ENG	205-2	Linear Algebra and Mechanics
GEN ENG	205-3	Dynamic System Modeling
GEN ENG	205-4	Differential Equations

IV. ENGINEERING DESIGN AND COMMUNICATION (3 courses)

Speech	102, or 103 or Taken at Medical School	
IDEA	106-1, 2	Engineering Design and Communication (0.5 each) plus English 106-1,2 (0.5 each).

V. BASIC ENGINEERING* (5 courses)

A. *Thermodynamics* - 1 course listed from those below

BMD_ENG	250	Thermodynamics
CHEM	342-1	Thermodynamics
MECH ENG	220	Thermodynamics I

B. *Fluids and Solids* - 2 courses as specified below

BMD_ENG	271	Introduction to Biomechanics <i>and</i>
BMD_ENG	270	Fluid Mechanics <i>or</i>
MECH ENG	241	Fluid Mechanics I

C. *Material Science* - 1 course listed from those below

MAT SCI	201	Principles of the Properties of Materials
MAT SCI	301	Chemical Aspects of Engineering Materials

D. *Probability, Statistics, and Quality Control* - 1 course listed from those below

BMD_ENG	220	Introduction to Biostatistics
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EECS	302	Probability Systems and Random Signals
IEMS	201	Introduction to Statistics
IEMS	303	Statistics I
MECH ENG	359	Reliability Engineering

* For those considering the Electronic Engineering track or the Computer Engineering track, see the note about basic engineering courses that precedes those track sections.

VI. SOCIAL SCIENCES/HUMANITIES THEME (7 courses)

6 courses at Evanston, 1 at Medical School

VII. MAJOR PROGRAM - PART I

A. Chemistry

CHEM	210-1, 2, 3	Organic Chemistry
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B. Biology

BIOL SCI	210-1, 2, 3	Biology
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C. Engineering

BMD_ENG	101	Introduction to Biomedical Engineering (zero credit seminar)
BMD_ENG	305	Biomedical Signals Analysis
BMD_ENG	306	Biomedical Systems Analysis
BMD_ENG	307	Quantitative Experimentation and Design

D. Tracks

Each student in the Biomedical Engineering Program completes his/her course of study either by selecting one of the following tracks or by an alternate set of courses developed with his/her advisor and submitted by petition to and approved by the BME Undergraduate Committee. Students should also be aware that 395 Special Topics courses are offered each year in BME and other departments, and may be used to count toward a track by petition.

Students in the Biomedical Signals and Images specialization area are encouraged to take BMD_ENG 302 and students in the Transport Processes and Tissue Engineering specialization area are encouraged to take BMD_ENG 301 if possible. Since these courses will be outside the 48 courses required for the degree, they may be taken P/N.

1. Biomechanics and Rehabilitation (Professors Ameer, Childress, Dhaher, Glucksberg, Hartmann, Johnson, Liu, MacIver, Murray, Perreault)

Take both of the following courses:

BMD_ENG	366	Biomechanics of Movement
BMD_ENG	371	Mechanics of Biological Tissue

Take one of the following courses:

BMD_ENG	346	Tissue Engineering
BMD_ENG	349	Bioregenerative Engineering

Take one of the following courses:

BMD_ENG	344	Biological Performance of Materials
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BMD_ENG	365	Human Limbs and their Artificial Replacements
BMD_ENG	377	Intermediate Fluid Mechanics in Engineering and Biology
CIV ENG	327	Finite Element Methods in Mechanics
MECH ENG	315	Theory of Machines-Design
MECH ENG	362	Stress Analysis
MECH ENG	389	Molecular Machines in Biology
MECH ENG	391	Fundamentals of Control Systems
EECS	360	Introduction to Feedback Systems

2. Transport Processes and Tissue Engineering (Professors Ameer, Ho, Johnson, Linsenmeier, Liu)

BMD_ENG	350	Transport Fundamentals
BMD_ENG	377	Intermediate Fluid Mechanics in Engineering and Biology

Take one of the following courses

BMD_ENG	346	Tissue Engineering
BMD_ENG	349	Bioregenerative Engineering

Take one of the following courses:

BMD_ENG	310	Molecular and Cellular Aspects of Bioengineering
BMD_ENG	315	Application of Genetic Engineering to Immunochemistry
BMD_ENG	317	Biochemical Sensors
BMD_ENG	343	Biomaterials and Medical Devices
MAT SCI	370	Biomaterials
BMD_ENG	344	Biological Performance of Materials
BMD_ENG	371	Mechanics of Biological Tissue
BIOL SCI	315	Cell Biology
BIOL SCI	390	Molecular Biology

3. Biological Materials and Molecular Engineering (Professors Ameer, Ho, Kelso, Liu, Messersmith, Wu)

BMD_ENG	314	Models in Biochemistry and Molecular Biology
BMD_ENG	317	Biochemical Sensors

Take one of the following courses:

BMD_ENG	343	Biomaterials and Medical Devices
MAT SCI	370	Biomaterials

Take one of the following courses:

BMD_ENG	344	Biological Performance of Materials
MAT SCI	331	Physical Properties of Polymers

4. Biomedical Signals and Images (Professors Backman, Carroll, D. Li, X. Li, Perreault, Tresch, Troy, Walsh)

BMD_ENG	325	Introduction to Medical Imaging
EECS	302	Probabilistic Systems and Random Signals

Take one of the following:

BMD_ENG	327 ⁺	Magnetic Resonance Imaging
BMD_ENG	333 ⁺	Modern Optical Microscopy and Imaging

Take one of the following courses:

BMD_ENG	323	Visual Science
BMD_ENG	327 ⁺	Magnetic Resonance Imaging
BMD_ENG	333 ⁺	Modern Optical Microscopy and Imaging
BMD_ENG	383	Cardiovascular Instrumentation
BMD_ENG	495	Biomedical Imaging Principles and Applications
EECS	328	Numerical Methods for Engineers
EECS	360	Introduction to Feedback Systems
PHY	357	Bio-Photonics Laboratory

⁺ BME 327 and BME 333 are listed in 2 places in this track because both courses can count toward this track. Neither course may not be double-counted, however.

The following 2 tracks allow alternate courses to be used for the basic engineering requirement to better prepare students for upper level courses within the track. These courses are listed below but must be approved by petition.

5. Computer Engineering (Professors Sahakian, X. Li)

V. Basic Engineering Courses:

EECS	202	Introduction to Electrical Engineering
EECS	203	Introduction to Computer Engineering
EECS	205	Fundamentals of Computer System Software

1 course from area VD - Probability, Statistics, and Quality Control
BME 250, BME 270, MECH ENG 241, or BMD_ENG 271

VIIIA. Core Courses – as listed

VIIIB. Specialization courses:

EECS	211	Programming for Computer Engineers (C++ programming)
EECS	303	Advanced Digital Logic Design
BMD_ENG	383	Cardiovascular Instrumentation

Take one of the following pair of classes

EECS	346	Microprocessor System Design <i>and</i>
EECS	347	Microprocessor System Projects (design, build, and embed a microprocessor)
EECS	361	Computer Architecture <i>and</i>
EECS	362	Computer Architecture Project
EECS	391	VLSI Systems Design <i>and</i>
EECS	392	VLSI Systems Design Projects (design an integrated circuit)

6. Electrical Engineering (Professors Sahakian, X. Li)

V. Basic Engineering Courses

EECS	202	Introduction to Electrical Engineering
EECS	203	Introduction to Computer Engineering – this is a prereq for EECS 303

- 1 course from area VB – Fluids and Solids
- 1 course from area VC – Materials Science
- 1 course from area VD – Probability, Statistics, and Quality Control

VIIIA. Core Courses – as listed

VIIIB Specialization courses

Take all of the following courses:

EECS	223	Fundamentals of Solid State Engineering
EECS	225	Fundamentals of Electronics
EECS	230	Programming for Computer Engineers
EECS	303	Advanced Digital Logic Design
BMD_ENG	383	Cardiovascular Instrumentation

VIII. MAJOR PROGRAM - PART II

Three science courses from the first two years of Medical School.

IX. FREE ELECTIVES

Four courses from the first two years of Medical School.

AP placement - Chemistry

Total number of courses for the BS degree: 48

Biomedical Engineering Courses
Offered in the McCormick School of Engineering and Applied Sciences

BMD_ENG 101 Introduction to Biomedical Engineering
BMD_ENG 220 Introduction to Biostatistics
BMD_ENG 250 Biothermodynamics
BMD_ENG 270 Introductory Biomedical Fluid Mechanics (with labs)
BMD_ENG 271 Introduction to Biomechanics
BMD_ENG 301 Systems Physiology I (with design)
BMD_ENG 302 Systems Physiology II
BMD_ENG 303 Systems Physiology III
BMD_ENG 308 Biomedical Engineering Laboratory (with labs and design)
BMD_ENG 310 Molecular and Cellular Aspect of Bioengineering (with labs and design)
BMD_ENG 314 Models in Biochemistry and Molecular Biology
BMD_ENG 315 Applications of Genetic Engineering to Immunochemistry
BMD_ENG 317 Biochemical Sensors
BMD_ENG 320 Biomedical Signals and Imaging (with design)
BMD_ENG 323 Visual Science (with design)
BMD_ENG 325 Introduction to Medical Imaging
BMD_ENG 327 Magnetic Resonance Imaging
BMD_ENG 333 Modern Optical Microscopy and Imaging (with design)
BMD_ENG 343 Biomaterials and Medical Devices
BMD_ENG 344 Biological Performance of Materials
BMD_ENG 346 Tissue Engineering (with labs and design)
BMD_ENG 349 Bioregenerative Engineering (with labs and design)
BMD_ENG 350 Transport Fundamentals
BMD_ENG 365 Human Limbs and Their Artificial Replacements
BMD_ENG 366 Biomechanics of Movement
BMD_ENG 371 Mechanics of Biological Tissues
BMD_ENG 377 Intermediate Fluid Mechanics in Engineering and Biology
BMD_ENG 383 Cardiovascular Instrumentation (with design)
BMD_ENG 384 Biomedical Computing (with design)
BMD_ENG 390-1,2 Biomedical Engineering Design (with design)
BMD_ENG 395 Special Topics in Biomedical Engineering (see list below)
BMD_ENG 401 Advanced Systems Physiology I (with design)
BMD_ENG 402 Advanced Systems Physiology II (with design)
BMD_ENG 403 Advanced Systems Physiology III
BMD_ENG 420 Biostatistics for Experimenters
BMD_ENG 427 Advanced MR Imaging
BMD_ENG 429 Advanced Physical and Applied Optics
BMD_ENG 445 Macromolecular Biomaterials
BMD_ENG 450 Biomedical Transport Phenomena
BMD_ENG 452 Transport through Connective Tissue
BMD_ENG 460 Neural Engineering: Fundamentals
BMD_ENG 461 Neural Engineering: Computational Neuromechanics and Neuroethology
BMD_ENG 462 Neural Engineering: Sensory Acquisition through Movement
BMD_ENG 463 Systems Neuropathophysiology
BMD_ENG 464 Neuromechatronics
BMD_ENG 466 Neuromuscular Biomechanics
BMD_ENG 467 Biomedical Robotics
BMD_ENG 469 Neural Control and Mechanics of Movement
BMD_ENG 475 Cardiovascular Biology and Engineering
BMD_ENG 495 Advanced Special Topics in Biomedical Engineering (see list below)

Special Topics in BME:

BMD_ENG 495 Biomedical Imaging: Principles and Applications