

# BIOMEDICAL ENGINEERING DEPARTMENT

## MEDICAL ENGINEERING UNDERGRADUATE CURRICULUM

2006-2007 (as of 10/25/06)

*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 (ESAPPM 253 may replace GEN ENG 205-4)

### 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 from 6 areas: no more than one course per area)

#### A. Thermodynamics

BMD\_ENG 250 Biothermodynamics

CHEM 342-1 Thermodynamics

MECH ENG 220 Thermodynamics I

#### B. Fluids and Solids

BMD\_ENG 270 Introductory Biomedical Fluid Mechanics

BMD\_ENG 271 Introduction to Biomechanics

CHEM ENG 321 Fluid Mechanics

CIV ENG 216 Mechanics of Materials

MECH ENG 241 Fluid Mechanics I

#### C. Material Science

MAT SCI 201 Principles of the Properties of Materials

MAT SCI 301 Chemical Aspects of Engineering Materials

*D. Electrical Science*

EECS	202	Introduction to Electrical Engineering
EECS	270	Applications of Electronic Devices

*E. Computer Architecture and Numerical Methods*

EECS	203	Introduction to Computer Engineering
EECS	328	Numerical Methods for Engineers

*F. Probability, Statistics, and Quality Control*

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

**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	308	Biomedical Engineering Laboratory
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One of the following areas of specialization or an alternate set of courses developed with a student advisor and submitted to and approved by the Biomedical Engineering Undergraduate Committee.

*Students should be aware that 395 Special Topics courses are offered each year in BME and other departments, and may be used to count toward an area of specialization 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. Electronic Instrumentation**

*a. Computer Applications*

Take EECS 202 under Basic Engineering V-D

Take EECS 203 under Basic Engineering V-E

BMD_ENG	320	Biomedical Signals and Images
BMD_ENG	325	Introduction to Medical Imaging
EECS	205	Fundamentals of Computer Systems Software
EECS	303	Advanced Digital Logic Design

Take one of the following pair of classes

EECS	346	Microprocessor System Design <i>and</i>
EECS	347	Microprocessor System Projects
EECS	361	Computer Architecture <i>and</i>
EECS	362	Computer Architecture Project
EECS	391	VLSI Systems Design <i>and</i>
EECS	392	VLSI System Design Projects

*b. Electronic Instrumentation*

Take EECS 202 under Basic Engineering V-D

Take EECS 203 under Basic Engineering V-E

Take one of the following two courses:

BMD_ENG	320	Biomedical Signals and Images
EECS	222	Fundamentals of Signals and Systems

Take all of the following courses:

EECS	221	Fundamentals of Circuits
EECS	223	Fundamentals of Solid State Engineering
EECS	225	Fundamentals of Electronics

Take 2 of the following courses:

EECS	230	Programming for Computer Engineers
BMD_ENG	303	Advanced Digital Logic Design
BMD_ENG	383	Cardiovascular Instrumentation

**2. Biomechanics and Rehabilitation**

Take BMD\_ENG 250 or CHEM 342 under Basic Engineering V-A

Take BMD\_ENG 271 under Basic Engineering V-B

BMD_ENG	366	Biomechanics of Movement
BMD_ENG	371	Mechanics of Biological Tissue

Take one of the following courses:

BMD_ENG	270	Introductory Biomedical Fluid Mechanics
MECH_ENG	241	Fluid Mechanics

Take one of the following courses:

BMD_ENG	346	Tissue Engineering
BMD_ENG	349	Bioregenerative Engineering

Take two of the following courses:

BMD_ENG	344	Biological Performance of Materials
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	390	Introduction to Dynamic Systems
MECH ENG	391	Fundamentals of Control Systems

### 3. Transport Processes and Tissue Engineering

Take BMD\_ENG 250 or CHEM 342 under Basic Engineering V-A

Take BMD\_ENG 270 or MECH ENG 241 or CHEM ENG 321 under Basic Engineering V-B

BMD_ENG	271	Introduction to Biomechanics
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 two 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
BMD_ENG	344	Biological Performance of Materials
BMD_ENG	371	Mechanics of Biological Tissue
BMD_ENG	377	Intermediate Fluid Mechanics in Engineering and Biology
BIOL SCI	315*	Cell Biology
BIOL SCI	390*	Molecular Biology

\*Only 1 of these courses may be counted toward the specialization

### 4. Biological Materials and Biotechnology

Take BMD\_ENG 250 or CHEM 342 under Basic Engineering V-A

Take BMD\_ENG 270 or MECH ENG 241 under Basic Engineering V-B

Take MAT SCI 201 under Basic Engineering V-C

BMD_ENG	314	Models in Biochemistry and Molecular Biology
BMD_ENG	317	Biochemical Sensors
BMD_ENG	343	Biomaterials and Medical Devices

BMD\_ENG 350 Transport Fundamentals

Take one of the following courses:

BMD\_ENG 344 Biological Performance of Materials  
MAT SCI 331 Physical Properties of Polymers

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 333 Modern Optical Microscopy and Imaging  
BMD\_ENG 346\* Tissue Engineering  
BMD\_ENG 349\* Bioregenerative Engineering  
BMD\_ENG 377 Intermediate Fluid Mechanics in Engineering and Biology  
BIOL SCI 301+ Biochemistry  
BIOL SCI 315+ Cell Biology  
BIOL SCI 390+ Molecular Biology

\*Only one of these courses may be counted toward the specialization

+ Only one of these courses may be counted toward the specialization

## 5. Biomedical Signals and Images

Take EECS 202 under Basic Engineering V-D

BMD\_ENG 320 Biomedical Signals and Imaging  
BMD\_ENG 325 Introduction to Medical Imaging  
BMD\_ENG 395 Dynamics of Biological Systems

Take one of the following courses:

EECS 360 Introduction to Feedback Systems  
MECH ENG 391 Fundamentals of Control Systems I

Take two 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 384 Biomedical Computing (not offered in '06-'07)  
BMD\_ENG 495 Biomedical Imaging Principles and Applications  
EECS 328 Numerical Methods for Engineers  
EECS 359 Digital Signal Processing

## 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 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 445 Macromolecular Biomaterials  
BMD\_ENG 450 Biomedical Transport Phenomena  
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 466 Neuromuscular Biomechanics  
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 395 Advanced BME Design (with design)  
BMD\_ENG 395 Dynamics of Biological Systems

**Special Topics in BME:**

BMD\_ENG 495 Biomedical Imaging: Principles and Applications  
BMD\_ENG 495 Dynamics of Biological Systems