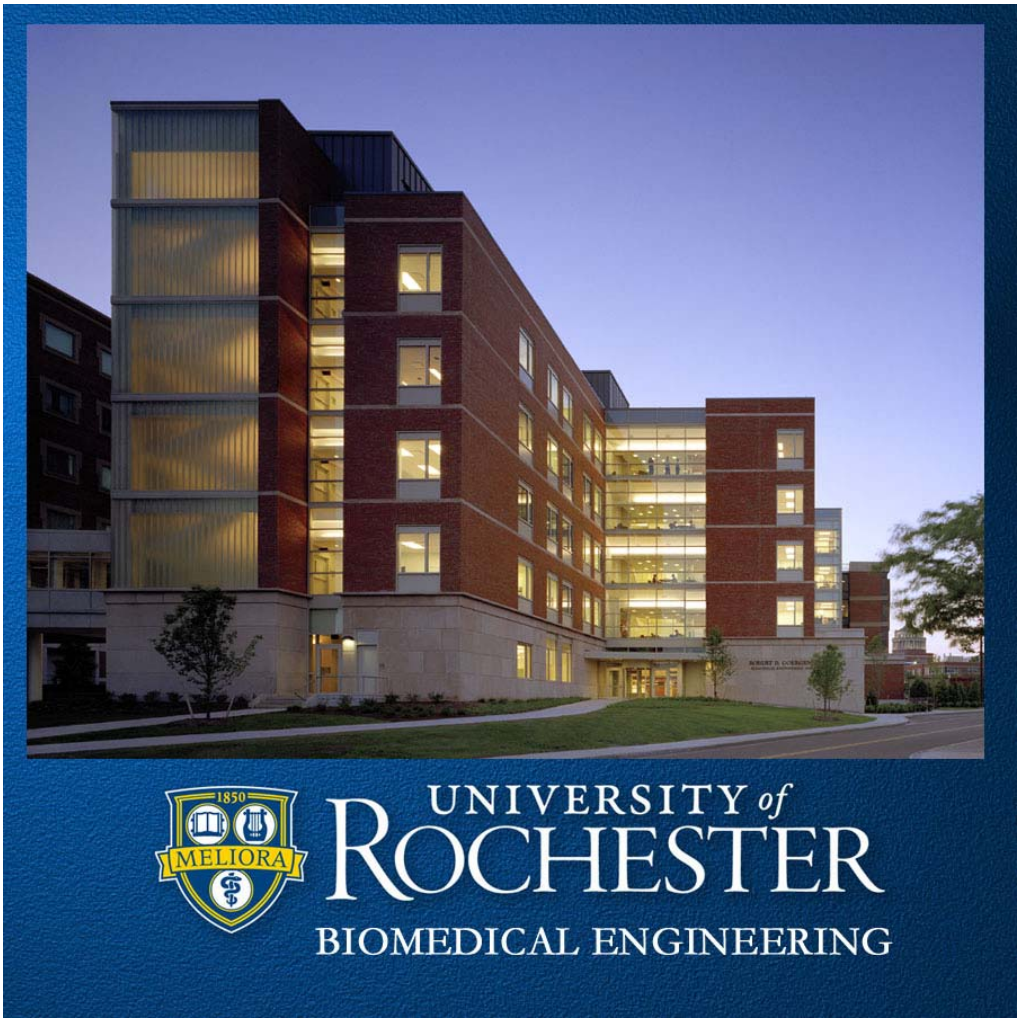
BASIC UNDERGRADUATE CURRICULUM GUIDE

SEPTEMBER 2009



Dottie Welch
206 Goergen Hall
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BME PRIMARY FACULTY

Chair of the Department

Richard E. Waugh, Ph.D. (Duke) *Professor of Biomedical Engineering, of Pharmacology and Physiology, of Biochemistry and Biophysics, and of Mechanical Engineering*

Research Area - Mechanical and thermodynamic properties of biological membranes; cellular mechanics and function of cytoskeletal proteins

Laurel Carney, Ph.D. (Wisconsin) Professor of Biomedical Engineering and of Neurobiology and Anatomy

Research Area – Auditory Neuroscience; neurophysiological, behavioral, and computational studies of hearing; signal processing for hear aids

Diane Dalecki, Ph.D. (Rochester) Associate Professor of Biomedical Engineering and of Electrical and *Computer Engineering, and Director of The Rochester Center for Biomedical Ultrasound*

Research Area - Biomedical ultrasound, acoustics, lithotripsy, biological effects of ultrasound

Amy L. Lerner, Ph.D. (Michigan) *Associate Professor of Biomedical Engineering and of Mechanical Engineering*

Research Area - Orthopedic biomechanics, bone growth and development, cartilage mechanics, medical image-based finite element modeling, knee biomechanics

Anne E. Luebke, Ph.D. (Johns Hopkins) *Associate Professor of Biomedical Engineering and of Neurobiology and Anatomy*

Research Area - Gene transfer to the cochlear, stem cell transfection, molecular biology of auditory efferent system receptors

Axel Wismüeller, M.D. (Tech. Univ. of Munich, Germany), *Associate Professor of Biomedical Engineering and of Imaging Sciences*

Hani Awad, Ph.D. (Cincinnati) *Assistant Professor of Biomedical Engineering and of Orthopaedics*

Research Area - Biomechanics of connective tissues, functional biomaterials of connective tissue, physicochemical regulation of engineered tissues, tissue engineering bioreactors, differentiation of stem cells, skeletal phenotyping of genetically altered mice

Danielle Benoit, Ph.D. (University of Colorado) *Assistant Professor of Biomedical Engineering*

Research Area -Tissue engineering, polymers, scaffolds, stem cells, musculoskeletal tissues, biomaterials, drug delivery, siRNA

Edward Brown III, Ph.D. (Cornell) *Assistant Professor of Biomedical Engineering*

Research Area - Multi-photon microscopy for studies of vasculogenesis and tumor diagnostics

Kevin Davis, Ph.D. (Boston) *Assistant Professor of Biomedical Engineering and of Neurobiology and Anatomy*

Research Area- Auditory neurophysiology, neural circuitry & information processing, and computational neuroscience

Gregory Gdowski, Ph.D. (Boston) *Assistant Professor of Biomedical Engineering and of Neurobiology and Anatomy*

Research Area - Vestibular neurophysiology: sensory neural control underlying the coordination of voluntary and reflexive postural movements

Mathews Jacob, Ph.D. (Swiss Federal Inst. Of Tech., Switzerland) *Assistant Professor of Biomedical Engineering, Electrical and Computer Engineering, and of Imaging Sciences.*

Research Area – Biomedical imaging, signal and image processing, magnetic resonance imaging, near infrared spectroscopic imaging

Nicholas Kuzma – Ph.D. (Yale) *Assistant Professor Biomedical Engineering*

Research Area - Medical imaging and magnetic resonance

Stephen McAleavey, Ph.D. (Rochester) *Assistant Professor of Biomedical Engineering*

Research Area - Biomedical ultrasound, medical imaging, image guided therapy, applications of time delay estimation

BME PRIMARY FACULTY (continued)

James McGrath, Ph.D. (M.I.T.) *Assistant Professor of Biomedical Engineering*
Research Area - Cell mechanics and motility, endothelial monolayer function, actin-based motility of pathogens
David J. Pinto, Ph.D. (Pittsburgh),*Assistant Professor of Biomedical Engineering and of Neurobiology &Anatomy*
Research Area - Neural control of somatosensory processing; experimental models of epilepsy; Mathematical and computation modeling of neuronal systems
Scott Seidman, Ph.D. (Case Western) *Assistant Professor of Biomedical Engineering and of Neurobiology and Anatomy*
Research Area - Neural control and mathematical modeling of reflex eye movements, physiological control systems

JOINT APPOINTMENTS WITH BIOMEDICAL ENGINEERING

Alfred Clark, Jr., Ph.D. (M.I.T.) *Professor of Mechanical Engineering, of Mathematics, and of Biomedical Engineering*
Gregory DeAngelis Ph.D. (California, Berkeley) *Professor of Brain and Cognitive Sciences, of Biomedical Engineering, of Neurobiology and Anatomy and in the Center for Visual Science*
David Dean (UC Berkeley) *Professor of Pediatrics and Biomedical Engineering*
Virkrim Dogra (University of Madras, India) *Professor of Radiology and Biomedical Engineering*
Philippe M. Fauchet Ph.D. (Stanford) *Distinguished Professor of Electrical and Computer Engineering, of Materials Science, of Optics, and of Biomedical Engineering, and Senior Scientist in the Laboratory for Laser Energetics, and Director of the Center for Future Health*
Bruce M. Fenton, Ph.D. (California, San Diego) *Professor of Radiation Oncology and of Biomedical Engineering*
Robert D. Frisina, Ph.D. (Syracuse) *Professor of Otolaryngology, of Biomedical Engineering, and of Neurobiology and Anatomy*
Sheryl Gracewski, Ph.D. (California, Berkeley) *Professor of Mechanical Engineering and of Biomedical Engineering*
Duncan T. Moore, Ph.D. (Rochester) *Professor of Optics and of Biomedical Engineering and Rudolph and Hilda Kingslake Professor of Optical Engineering Science*
Ruola Ning, Ph.D. (Utah) *Professor of Radiology and of Electrical and Computer Engineering*
Gary Paige, M.D. (Chicago) *Kilian J. and Caroline F. Schmitt Professor of Neurobiology and Anatomy, of Neurology, of Ophthalmology, of Brain and Cognitive Sciences, in the Center for Visual Science, and of Biomedical Engineering; Chair of Neurobiology and Anatomy*
Kevin J. Parker, Ph.D. (M.I.T.) *Professor of Electrical and Computer Engineering, of Radiology, and of Biomedical Engineering; Dean, School of Engineering and Applied Sciences*
Renato Perucchio, D. Engr. (Pisa, Italy) *Professor of Mechanical Engineering and of Biomedical Engineering, and Associate Professor of Pediatrics*
J. Edward Puzas, Ph.D. (Rochester) *Donald and Mary Clark Professor of Orthopaedics and of Biomedical Engineering*
Ingrid H. Sarelius, Ph.D. (Auckland, New Zealand) *Professor of Pharmacology and Physiology and of Biomedical Engineering*
Michael C. Schell, Ph.D. (Wisconsin, Madison) *Professor of Radiation Oncology and of Biomedical Engineering*
Denham S. Ward, M.D. (Miami) *Professor of Anesthesiology and of Biomedical Engineering*

JOINT APPOINTMENTS WITH BIOMEDICAL ENGINEERING (continued)

David R. Williams, Ph.D. (California, San Diego) *William G. Allyn Professor of Medical Optics, Professor of Brain and Cognitive Sciences, of Optics, of Psychology, of Optics, of Ophthalmology, and of Biomedical Engineering; and in the Center for Visual Science; Director of the Center for Visual Sciences*

J. H. David Wu, Ph.D. (M.I.T.) *Professor of Chemical Engineering, of Microbiology and Immunology, and of Biomedical Engineering*

Jianhui Zhong, Ph.D. (Brown) *Professor of Radiology and of Biomedical Engineering, and of Physics*

Andrew Berger, Ph.D. (M.I.T.) *Associate Professor of Optics and of Biomedical Engineering*

Patricia Chess, M.D. (Columbia) *Associate Professor of Pediatrics and of Biomedical Engineering*

Edward G. Freedman, Ph.D. (Pennsylvania) *Associate Professor of Neurobiology and Anatomy, of Biomedical Engineering, and in the Center for Visual Science*

Denise Hocking, Ph.D. (Albany) *Associate Professor of Pharmacology and Physiology and of Biomedical Engineering*

Ben Miller, Ph.D. (Stafford) *Associate Professor of Dermatology, of Biochemistry and Biophysics, and of Biomedical Engineering*

Jack G. Mottley, Ph.D. (Washington, St. Louis) *Associate Professor of Electrical and Computer Engineering and of Biomedical Engineering*

Wael Saad (Ain Shams University, Egypt) *Associate Professor of Imaging Sciences and Biomedical Engineering*

Edward M. Schwarz, Ph.D. (Albert Einstein College of Medicine) *Associate Professor of Orthopaedics, of Microbiology and Immunology, of Urology, of Medicine, of Pathology and Laboratory Medicine, and of Biomedical Engineering*

James M. Zavislan, Ph.D. (Rochester) *Associate Professor of Optics, of Dermatology, of Ophthalmology, and of Biomedical Engineering*

David Borkholder (Stanford) *Assistant Professor, Electrical Engineering, Rochester Institute of Technology, and Adjunct Associate Professor of Biomedical Engineering*

Lisa A. DeLouise, Ph.D. (Pennsylvania State) *Assistant Professor of Dermatology and of Biomedical Engineering*

Jeffery Houck, Ph.D. (University of Iowa) *Adjunct Assistant Professor of Biomedical Engineering*

Walter O'Dell, Ph.D. (Johns Hopkins) *Assistant Professor of Radiation Oncology and of Biomedical Engineering*

Keith Schneider, Ph.D. (Rochester) *Assistant Professor (Research) in the Center for Brain Imaging and of Biomedical Engineering*

Geunyoung Yoon, Ph.D. (Osaka) *Assistant Professor of Ophthalmology, of Biomedical Engineering, and in the Center for Visual Science*

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Geunyoung Yoon, Ph.D. (Osaka) *Assistant Professor of Ophthalmology, of Biomedical Engineering, and in the Center for Visual Science*

AFFILIATED FACULTY

Arthur Moss, M.D. (Harvard) *Professor of Medicine*
Alice Pentland, M.D. (Michigan) *James H. Sterner Professor of Dermatology; Medical Director of Center for Future Health and Chair of Dermatology*
Deborah Rubens, M.D. (Rochester) *Professor of Imaging Sciences; Associate Chair of Imaging Sciences*
Shey-Shing Sheu, Ph.D. (Chicago) *Professor of Pharmacology and Physiology, of Medicine, and of Anesthesiology*
Peter G. Shrager, Ph.D. (California, Berkeley) *Professor of Neurobiology and Anatomy*
Paul E. Bigeleisen, M.D. (California, Davis) *Associate Professor of Anesthesiology*
Karl Schwarz, M.D. (Rochester) *Associate Professor of Medicine and of Biomedical Engineering*
Xucai Chen, Ph.D. (Yale) *Assistant Professor of Medicine, of Electrical and Computer Engineering, and of Biomedical Engineering*
Jean-Philippe Couderc, Ph.D. (National Institute of Applied Science, Lyon, France) *Research Assistant Professor of Medicine*
Edwin Carstensen, Ph.D. (University of Pennsylvania) *Arthur Gould Yates Professor Emeritus of Engineering and Senior Scientist in Electrical and Computer Engineering*

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INTRODUCTION

Biomedical Engineering (BME) involves the application of engineering science and technology to solve problems in biology and medicine. This broad area offers many career opportunities, ranging in scope from advanced research to engineering practice in industrial or clinical settings. The Department of Biomedical Engineering, in conjunction with strong academic programs in the basic sciences and other engineering disciplines at the University of Rochester, offers outstanding training in this rapidly growing field.

B.S. IN BIOMEDICAL ENGINEERING

The Bachelors of Science degree program in Biomedical Engineering at the University of Rochester is one of only *45)* that are accredited by ABET. Our curriculum emphasizes fundamental engineering and design principles taught in the context of current problems in medicine and biology. A series of nine core courses required of all BME students provides a solid foundation in engineering principles relevant to biomedical engineering practice. To ensure in-depth training in engineering, students are required to complete a sequence of four engineering courses in a focus area of biomedical engineering. These areas of concentration are Biomechanics, Biosignals & Biosystems, Cell and Tissue Engineering, and Medical Optics. The program is capped with a biomedical engineering senior design course required for all students. This program requires a total of (130 credit hours), which includes a minimum of 42 credit hours devoted to mathematics and natural sciences and a minimum of 50 credit hours devoted to engineering.

The Undergraduate Program

The interdisciplinary nature of biomedical engineering requires expertise in both the biological and engineering sciences. The University of Rochester offers several avenues of academic study in biomedical engineering, each of which can be structured to satisfy pre-medical or pre-dental requirements. The University of Rochester offers B.S., M.S. and Ph.D. programs in biomedical engineering. The Minor in biomedical engineering (24 credits) provides opportunities for students majoring in other disciplines to obtain substantive exposure to the field of biomedical engineering. Minor requirements are listed on the BME website: http://www.bme.rochester.edu/

DEPARTMENTAL MISSION AND PROGRAM EDUCATIONAL OBJECTIVES

Mission

"As members of the Department of Biomedical Engineering at the University of Rochester, our mission is to create and disseminate knowledge in engineering related to basic biomedical sciences and health care applications, and to provide students with the foundational knowledge and skills in biomedical engineering that they will need to become and remain leaders in their chosen field."

Undergraduate Program Educational Objectives

The overall educational objective of our program is to develop effective practitioners in biomedical engineering and associated fields. We expect that our graduates will contribute to advancement of their chosen field, while remaining mindful of the ethical and social implications of their work. They will have confidence in their abilities to apply foundational knowledge in the basic sciences, mathematics, engineering analysis, and design to address a wide range of problems in medicine and biology. In keeping with the continuously evolving nature of the field of biomedical engineering, we expect that our alumni will engage in lifelong learning, and that many of them, inspired by research experiences as undergraduates, will continue their education in advanced degree programs.

BME CURRICULUM AND REQUIREMENTS

Basic Science & Math Courses (38 credit hours) See Appendix #1 for full course names
Nine courses in natural sciences and mathematics divided as follows:
Four Math courses - MTH 161, 162, 163 **or** 165, 164
(MTH 141, 142, & 143 are equivalent to MTH 161 & 162)
Two Chemistry courses - CHM 131 and CHM 132 (5 credits each)
Two Physics courses - PHY 121, 122
One Biology course - BIO 110

Core BME Courses (31 credit hours)
The curriculum features a series of core BME courses that aims to provide students with a breadth of knowledge and skills in the field of biomedical engineering. The following courses form the BME Core.
(See Appendix#2 for course descriptions)
BME 101 - Introduction to Biomedical Engineering
BME 201 - Fundamentals of Biomechanics
BME 201 P - MATLAB for Biomechanics (1 credit)
BME 210 - Biosystems and Circuits
BME 221 - Biomedical Computation
BME 230 - Biomedical Signals & Measurements
BME 260 - Quantitative Physiology with lab
BME 295 - BME Design Seminar (2 credits)
BME 296 - BME Senior Design

Basic Science Electives (12 credit hours)
All students must complete at least three additional courses (at least 12 credit hours) in the basic sciences beyond the required introductory biology (BIO 110), chemistry (CHM 131 & CHM 132), and physics (PHY 121/141 & PHY 122/142) courses. Any biology, microbiology, neuroscience, chemistry, or physics course with number greater than 109 may be used to fulfill this requirement (excluding BIO 111, 112, 113). At least two of these courses must have a laboratory component. At least two courses must be life science courses (i.e., biology, microbiology, neuroscience). Students are encouraged to choose their basic science electives to complement their BME concentration area. Independent study courses cannot be used to satisfy this requirement.

Some recommendations for Basic Science Elective sequences are provided below.
Example 1:
BIO 203 – Mammalian Anatomy (4 credits, fall, includes laboratory component)
BIO 204 – Mammalian Physiology (4 credits, spring, includes laboratory component)
PHY 123 – Modern Physics (4 credits, spring)

*Example 2: (This sequence is **required** for students in the Cell & Tissue Engineering Concentration)*
CHM 203 – Organic Chemistry I (4 credits, fall) with CHM 207 – Organic Chem. Lab I (1 credit, fall)
BIO 250 – Biochemistry (4 credits, spring) with BIO 151 – Intro. to Biochemistry Lab (1 credit, spring)
BIO 210 – Molecular Cell Biology (4 credits, fall)

Example 3:
CHM 203 – Organic Chemistry I (4 credits, fall)
BIO 250 – Biochemistry (4 credits, spring) with BIO 151 – Intro. to Biochemistry Lab (1 credit, spring)
BIO 198 – Principles of Genetics (4 credits, fall) with BIO 198L – Genetics Lab (1 credit, fall)

Example 4:
BIO 203 – Mammalian Anatomy (4 credits, fall, includes laboratory component)
NSC 201 – Basic Neurobiology (4 credits, fall) with NSC 201L – Basic Neurobiology Lab (1 credit, fall)

NSC 221 – Audition (4 credits, spring)

Example 5: (Pre-Med -these requirements include two semesters of organic chemistry with laboratories and two semesters of biology with laboratories. Thus, students will need to use at least one free elective to fulfill pre-medical science requirements.
CHM 203 – Organic Chemistry I (4 credits, fall) with CHM 207 – Organic Chemistry Lab I (1 credit, fall)
BIO 204 – Mammalian Physiology (4 credits, spring, includes laboratory component)
BIO 198 – Principles of Genetics (4 credits, fall) with BIO 198L – Genetics Lab (1 credit, fall)

Technical Elective (4 credit hours)
An ***engineering course*** with the course number higher than 109 can be used to fulfill the technical elective requirement. Suitable courses must have significant engineering design, analysis, synthesis, or technical components.

The following courses ***may not*** be used towards the technical elective requirement ECE 111, ECE 113, ECE 399, ChE 211, ChE 290, ME 120, ME 163, ME 164, ME 202, ME 211, OPT 287, any EAS course. Classes that are primarily mathematics or science courses **may not** be used. Classes that are equivalent to core or concentration courses **are disallowed**, e.g. ME 225 Fluid Mechanics cannot be used as a technical elective when ChE 243 Fluid Dynamics has already been taken to fulfill the concentration requirements and vice versa. Courses that are cross-listed with non-SEAS departments (e.g. ChE277/AAS277) **must** be taken under the SEAS registration. Petition forms can be obtained from Dottie Welch, Goergen 206.

Cluster and Humanities & Social Sciences (H/SS) (16 credit hours)
All BME majors must complete a total of **four** courses in humanities and/or social sciences. Three of these courses must constitute an approved Cluster in Humanities or Social Sciences and must be passed with a 2.0 average or better. See the Cluster Search Engine on the UR website to review courses and descriptions:
http://www.rochester.edu/College/CCAS/clusters/cluster_directory7.html
The fourth course can be chosen from any recognized Humanities or Social Science field. Courses in the business field may not be used to satisfy the additional course requirement. Students are expected to take some of these courses beyond the introductory level.

Some tracks for the Certificate of Management Studies will satisfy the cluster requirement. Those stating Social Science Cluster - See the website:
http://www.rochester.edu/College/CCAS/certificates/cert_management.html
**A second major or minor in a Humanities or Social Science (H/SS) area will also satisfy the cluster and additional H/SS course requirement.
No computer courses offered in humanities or social science fields may be used as a H/SS distribution course.

Primary Writing Requirement (4 credit hours)
The Primary Writing Requirement must be satisfied before admission to the program. (CAS 105 - Reason and Writing) See the website:
http://www.rochester.edu/College/CCAS/AdviserHandbook/PrimWrReq.html
and the listings for CAS 105 course schedules website:
http://www.rochester.edu/college/Writing/schedules.html

Free Electives (9 credit hours)
Any courses taken at the UR, AP courses or transfer courses

Upper Level Writing Requirement

Significant writing experience in one's discipline is an important adjunct to the technical material one learns. As of 7/01, the courses that fulfill the University's Upper Level Writing Requirement courses by placing significant weight on the effectiveness of written communication are: BME 221, BME 230, BME 260, BME 296, and any upper level BME course. Students who use transfer credit for any one or more of these courses from another institution to the UR must consult with their faculty advisor to determine if their program satisfies the requirement.

BME Concentration Courses (16 credit hours)

Students choose to concentrate in one of four BME specialty areas. Four engineering courses are required to form a sequence in one of the following areas. Biosignals & Biosystems, Biomechanics, Cell & Tissue Engineering, or Medical Optics. Each concentration includes an upper level BME course in the specialty area. Courses for each concentration and example course schedules are given below.

Biosignals & Biosystems

ECE 241-Signals
ECE 221-Electronic Devices & Circuits **or** ECE 230- Electromagnetic Waves
ECE 246 – Digital Signal Processing
Upper Level BME: e.g. BME 251-Biomedical Ultrasound, ECE 452-Medical Imaging, BME 218 Introduction to Neuroengineering

Biomechanics

ME 226-Introduction to Solid Mechanics
ME 225-Introduction to Fluid Dynamics
ME 123-Thermodynamics
Upper Level BME: e.g. BME 283-Biosolid Mechanics

Cell & Tissue Engineering

CHE 243-Fluid Dynamics
CHE 244-Heat & Mass Transfer
CHE 225-Thermodynamics
Upper Level BME: e.g. BME 262 Cell & Tissue Engineering

Medical Optics

OPT 241-Geometrical Optics
OPT 261-Interference & Diffraction
OPT 262-Electromagnetic Theory **or** OPT 224-Laser Systems
PHY 123 – Wave and Modern Physics Basic Science Elective
Upper Level BME: e.g. OPT 276-Biomedical Optics or BME 270 –Biomedical Microscopy

FIRST & SECOND YEAR
FOR ALL BME STUDENTS

1st Year

Fall	**Spring**
MTH 161*-Calculus IA	MTH 162*-Calculus IIA
CHM 131-Chem. Concepts I (lab)	CHM132 -Chem. Concepts II (lab)
BME 101-Intro. to BME *(Core)*	PHY 121-Mechanics (lab)
Primary Writing **or** H/SS	H/SS **or** Primary Writing

2nd Year

Fall	**Spring**
MTH 163 **or** 165**-Differential Equations	MTH 164-Multidimensional Calculus ***
PHY 122-Electricity & Magnetism (lab)	Basic Science Elective or 1st concentration course****
BIO 110-Principles of Biology I	BME 210-Biosystems & Circuits (lab) *(Core)*
BME 201-Fund. of Biomechanics *(Core)*	H/SS*****
BME 201L – MATLAB for Biomechanics - 1cr.	

*An alternative to the MTH 161 and 162 sequence is the MTH 141, 142 and 143 sequence. Careful attention must be paid to the effects of this longer sequence, including the possible need to take a course in the summer following the first year. MTH171 series can be used to fulfill the Math requirements

** Either MTH 163 or 165 will satisfy the math requirements of the BME program.

***Math 164 may be taken before MTH 163 – both courses are taught Fall & Spring

**** C&T must take CHE243, Biomechanics should take ME226 and Medical Optics should take OPT261

In each concentration one of the four electives must be a Technical Elective. Humanities, Social Sciences, and Elective courses can be taken in any semester.

CELL & TISSUE ENGINEERING

3rd Year

Fall	**Spring**
ELECTIVE	Elective
CHE 244 - Heat & Mass Transfer	H/SS
BME 221 - Biomedical Computation *(Core)*	BME 230 - Signals & Measurements (lab) *(Core)*
CHM 203-Orgo I & 207 Lab	BIO 250-Biochemistry & 151 Lab

4th Year

Fall	**Spring**
BME 260 - Quantitative Physiology *(Core)*	BME 296 - Senior Design (lab)*(Core)*
BME 295 - Design Seminar (2 cr.) *(Core)*	BME 262 – Cell & Tissue Engineering
BIO210 - Molecular Cell Biology	ELECTIVE
CHE 225-Thermodynamics	ELECTIVE
H/SS	

BIOSIGNALS & BIOSYSTEMS

3rd Year

Fall	**Spring**
ECE 241 - Signals	ELECTIVE
ECE 221-Electronic Devices & Circuits **or**	H/SS
ECE230 – Electromagnetic Waves	BME 230 - Signals & Measurements in BME *(Core)*
BME 221 Biomedical Computation *(Core)*	Basic Science Elective
Basic Science Elective	

4th Year

Fall	**Spring**
BME 260 - Quantitative Physiology *(Core)*	BME 296 - Senior Design *(Core)*
BME 295 - Design Seminar (2 cr.) *(Core)*	Upper Level BME or ELECTIVE
ELECTIVE or Upper Level BME	ELECTIVE
ECE246-Digital Signal Processing	ELECTIVE
H/SS	

BIOMECHANICS

3rd Year

Fall	**Spring**
ELECTIVE	ME 123 - Thermodynamics
H/SS	ME 226 – Introduction to Solid Mechanics
BME 221 - Biomedical Computation *(Core)*	BME 230 - Signals & Measurements in BME *(Core)*
Basic Science Elective	Basic Science Elective

4th Year

Fall	**Spring**
BME 260 - Quantitative Physiology*(Core)*	BME 296 - Senior Design *(Core)*
BME 295 - Design Seminar (2 cr.) *(Core)*	ELECTIVE
ME 225 – Introduction to Fluid Dynamics	ELECTIVE
BME 283 – Biosolid Mechanics	Basic Science Elective
H/SS	

MEDICAL OPTICS

3rd Year

Fall	**Spring**
ELECTIVE	OPT 241 - Geometrical Optics
H/SS	OPT 261 – Interference & Diffraction
BME 221 - Biomedical Computation *(Core)*	BME 230 - Signals & Measurements in BME *(Core)*
Basic Science Elective	Basic Science Elective-PHY123

4th Year

Fall	**Spring**
BME 260 - Quantitative Physiology *(Core)*	BME 296 - Senior Design *(Core)*
BME 295 - Design Seminar (2 cr.) *(Core)*	OPT 262-Electromagnetic **or** ELECTIVE
Upper Level BME or Elective	ELECTIVE or Upper Level BME
ELECTIVE or OPT 224-Laser Systems	H/SS
H/SS	

ADMISSION REQUIREMENTS

Students wishing to major in Biomedical Engineering must file a completed "BME Curriculum Planning Form" (See Page 16) ordinarily during the fourth semester of study. This form constitutes application to the upper-division BME program. The minimum requirements for admission to the BME program are: completion of BME 101 BME 210 and BME 201 with 201P with a minimum GPA of 2.30 in these three courses; completion of the introductory science and math requirements (excluding the three Basic Science Requirements); a minimum cumulative GPA of 2.00, and completion of the University Primary Writing Requirement,

A BME career planning form (See Appendix 3) must accompany the major declaration forms. The university requirement that a student should be free of academic probation also applies. The submitted career plan, though never binding, is very useful in helping students to focus their interests within the field of biomedical engineering. Before preparing and submitting a course plan, each student should study available written material and then discuss the alternatives fully with his or her faculty advisor or with other faculty. The Curriculum Planning Form, approved and signed by the student's faculty advisor, will then be attached to a Declaration of Major Approval form and submitted to the SEAS Dean's Office.

Under special circumstances, such as transfer from another institution or a change of intended major in the early years of study, students may not complete all the requirements for admission by the end of the sophomore year. Students in such a situation may qualify for **conditional admission** by submitting a form, available from the BME Undergraduate Office, to the BME Undergraduate Committee along with an up-to-date BME Curriculum Planning Form. The application must present a realistic plan, approved by the student's advisor, for completion of all BME program admission requirements within one year. Failure to meet the requirements within one year will result in removal from the major.

Only the Administrative Committee of the School of Engineering and Applied Sciences can make exceptions from the general degree requirements published in the Official Bulletin of the University. Petition forms for Administrative Committee consideration may be obtained from the BME Undergraduate Office - Goergen 206.

GRADUATION REQUIREMENTS

For graduation biomedical engineering majors must achieve satisfactorily complete all course requirements consisting of a total of 130 credits with an overall cumulative grade point average of 2.00.

TRANSFER CREDITS

Prior approval is required if a student wishes to take a course at another institution to satisfy a BME degree requirement. An "Undergraduate Transfer Credit Approval Form," is available in the BME Undergraduate Office-Goergen 206. Students are strongly advised to seek the advice of their advisor before registering for a course at another institution.

FIVE-YEAR BS/MS PROGRAM (3/2 Program)

BME juniors contemplating graduate work should consider the special five-year, BS/MS program offered by the BME Department. This program provides the advantage of a smooth

transition between undergraduate and graduate study. Program enrollment is competitive and students must apply for admission in the spring of their junior year. Successful applicants can begin their masters-level study in the senior year. Through a special program initiated by the School of Engineering and Applied Science, students who have been formally accepted into the 3/2 program will be considered for a partial tuition scholarship for the fifth year of study.

Students should consult the UR *Graduate Studies Official Bulletin* for the MS degree requirements and they should meet with a faculty member to develop an integrated BS/MS program of study (required for admission.) *UR Graduate Studies Official Bulletins are available in the BME Undergraduate Office - Goergen 206.*

TAKE FIVE SCHOLAR PROGRAM

The Take Five Scholar Program provides students with opportunities to explore additional disciplines and courses that might not otherwise be available to them within the four year degree path. Accepted students will be granted one or two tuition-free semesters to take courses in addition to those needed to complete their degree. Students may apply from the time they have been formally accepted into their major through the first semester of their senior year. Transfer students must have completed one full semester at the University before applying. Website: http://www.rochester.edu/College/CCAS/TakeFive/

INTERNSHIPS AND INDUSTRY PRACTICUM

BME majors are strongly encouraged to participate in internships with local or nationally based engineering firms or research institutions. Only in a few cases can internship experiences be used for academic credit. Students who wish to obtain such credit for an internship must obtain prior approval from the BME Undergraduate Committee.

The Industry Practicum program is a way to gain valuable work experience. A student in this program takes one semester, and the summer preceding or following that semester to work for a company. Academic credit is not granted, but the work experience and references obtained are valuable in later career placements. Typically, graduation is delayed by one semester, but some students with Advanced Placement credit or summer classes can graduate on time. Additional information, including example programs, is available from the SEAS office or Career Center in Lattimore Hall .

Website: http://www.seas.rochester.edu/SEAS/options/ip.html

STUDY ABROAD

If you are considering spending a semester, a year or summer in another country please check out the UR website to explore the opportunities available to you. You will find numerous resources to help you plan your studies overseas.

See the website:http://www.rochester.edu/College/abroad/programs/index.html

Visit the Center for Study Abroad and Inter-department Programs as you plan. The Center is located in Lattimore 206, and is there to help you, to share your excitement and to assist you in making it all work.

PRE-MEDICAL PROGRAM

BME students interested in a pre-med program are urged to obtain related materials from the Health Professions Advisor at the Center for Academic Support, Lattimore 312. It is essential that

such students begin program planning very early and involve both their BME advisor and the Health Professions Advisor.

Website:http://www.bcs.rochester.edu/programs/undergraduate/pre-med.html

All of the courses usually required for admission to medical school are readily accommodated within the B,S, in BME curricular requirements. These include two semesters of general physics, two semesters of general chemistry, two semesters of Organic Chemistry with labs , two semesters of biology with labs, two semesters of math, and two semesters of English.

KAUFFMAN ENTREPRENUERIAL YEAR (KEY) PROGRAM

The University of Rochester defines entrepreneurship as "transforming an idea into an enterprise that generates value," implying that the enterprise outlives the creator and that it positively affects others. Qualified students may propose to devote as much as an entire academic year to internships, special projects, business plan development, research into various facets of entrepreneurship, or analysis of how culture and public policy influence entrepreneurial activity. Students may apply from the time that they have been accepted into a major through the second semester of their senior year.

* Participation is open to all undergraduates in the College and the Eastman School of Music with the following exceptions:
* Transfer students may not apply during their first semester at the University.
* Take Five Scholars may not apply for the KEY Program.

Applications are available at each of several information sessions held each semester, at the Academic Services Counter outside Lattimore 312 and on the web at http://www.rochester.edu/entrepreneurship/. Applications are due no later than November 1 st in the fall semester or the first Thursday after Spring Break in the spring term. Students should submit their KEY Program materials to Juliet Sullivan, Lattimore 312. Letters of recommendation are due the same day as the application and should be sent directly to Lattimore 312.

A list of courses that has been developed with entrepreneurship in mind can be found at www.rochester.edu/entrepreneurship/courses. Students should also consult the faculty with whom they want to study, and/or the appropriate departmental administrators to be sure that the courses they want to take will be offered, and that they are adequately prepared for the courses they intend to take. Each applicant needs to arrange for two full-time faculty members to send letters of recommendation to the KEY Review Board on his or her behalf.

NROTC

A maximum of two NROTC courses (8 credits) may be taken as free electives toward the 130 credits required for graduation. Additional NROTC courses must be taken as overloads.

APPENDIX #1

BIOMEDICAL ENGINEERING COURSES AND PRE-REQUISITES

BME 101 - Introduction to Biomedical Engineering

An introductory overview of the multi-disciplinary field of biomedical engineering. Application of elementary engineering principles to the analysis of physiological systems: topics include mechanics of the cell, organ systems, circulatory and musculoskeletal systems, medical instrumentation and medical imaging. Includes some guest lectures by biomedical engineering faculty. Prerequisites: for freshmen only or by permission of instructor.) Semester Taught: Fall - CREDITS: 4

BME 201 - Fundaments of Biomechanics

Teaches static and dynamic rigid body mechanics with applications in prosthetics, human movement, and other biomedical topics. Prerequisites: MTH 161 and 162, BME 101, PHY121 Semester Taught: Fall - CREDITS: 4

BME 201 P - MATLAB for Biomechanics

. Fundamentals of computer programming in MATLAB. Emphasis on programming basics, such as syntax, loop structures, logic, input/output, and graphics.- CREDITS:1

BME 210 – Biosystems & Circuits

Introduction to linear systems theory and electrical circuit theory. Examples will include bioelectric system and signals and models of biological systems. Semester Taught: Spring CREDITS: 4

BME 218/518 – Introduction to Neuroengineering

Introduces many aspects of neuroengineering research, with an emphasis on biologically plausible models of neurons, circuits, and systems. Prerequisites: BME 260, strong computing skills recommended or permission of instructor Semester Taught: Spring - CREDITS 4

BME 221 - Biomedical Computation

The application of numerical and statistical methods to model biological systems and interpret biological data, using the MATLAB programming language. Prerequisites: BME201,, BME201L or permission of instructor
Semester Taught: Fall -CREDITS: 4

BME 228/448 – Physiological Control Systems

This course focuses on the application of control theory to physiological systems. Lectures present modern control theory in the context of of physiological systems that utilize feedback mechanisms. Prerequisites: jniors with MTH164, MTH163/165, BME201L and ECE241 or equivalent. Seniors need BME230 in place of ECE241. Semester Taught: Spring-CREDITS 4

BME 230 – Biomedical Signals & Measurements

This course examines a range of instrumentation and techniques used in the acquisition, processing, and presentation of measurements of biological systems, and features an intensive laboratory. Lectures will cover transducers, sensors, digital electronics, Fourier analysis, elementary signal processing the ECG and EMG signals, flow measurement, and an introduction to medical imaging and biosensors. The laboratory experiments will concentrate on measurement instrumentation and techniques in biomedical engineering. Statistics and good laboratory practices are also covered . Laboratory sessions cover instrumentation amplifiers, bridge circuits, blood pressure measurement, the ECG/EMG signals, and nerve conduction velocity. Prerequisites: ECE 113 or ECE 210, or permission of instructor. Semester Taught: Spring (starting 2003) - CREDITS: 4

BME 251/451 - Biomedical Ultrasound

The physical basis for the use of high-frequency sound in medicine (diagnosis, therapy, and surgery) and biology. Topics include acoustic properties of tissues, sound propagation (both linear and nonlinear) in tissues, interactions of ultrasound with gas bodies(acoustic cavitation and contrast agents), thermal and non-thermal biological effects of ultrasound, ultrasonography, dosimetry, hyperthermia and lithotripsy. Prerequisites: Math 163, Math 164, Physics 122 or permission of instructor. Semester Taught: Spring - CREDITS: 4

BME 259 Transport Phenomena in Biological Systems

This course will provide an overview of transport phenomena in biological systems that are critical to the function of all living organisms. The fundamental laws and equations of transport phenomena will be applied to topics including cellular, cardiovascular, respiratory, liver and kidney transport, blood flow and reology, and circulation in tissues and arteries. Homework assignments, in-class quizzes, final exam and a technical paper or presentation

ME 260 - Quantitative Physiology

A quantitative, model-oriented approach to physiological systems is presented. Topics include the muscle and nerve tissue, the cardiovascular system, the respiratory system, the renal system, and a variety of neural systems. Prerequisites: ECE 111 or ECE 210, or permission of instructor. Semester Taught: Fall, - CREDITS: 4

BME 262/462 - Cell & Tissue Engineering

This course teaches the principles of modern cell and tissue engineering with a focus on understanding and manipulating the interactions between cells and their environment. After a brief overview of Cell and Tissue Engineering, the course covers 5 areas of the field. These are: 1) Physiology for Tissue Engineering; 2) Bioreactors and bimolecular production; 3) Materials for Tissue Engineering; 4) Cell Cultures and bioreactors and 5) Drug Delivery and Drug Discovery. Within each of these topics the emphasis is on analytical skills and instructors will assume knowledge of chemistry, mass transfer, fluid mechanics, thermodynamics and physiology consistent with the Cell and Tissue Engineering Track in BME. In a term project, undergraduate students must present written and oral reports on a developing or existing application of Cell and Tissue Engineering. The reports must address the technology behind the application, the clinical need and any ethical implications Prerequisites: BME 260, CHE 225, CHE 243, CHE 244 or permission of instructor. . Semester Taught: Spring - CREDITS 4 In a term project, graduate students must identify a technological need and present orally and in writing a proposal to meet the need.

BME 267/467 Models and Simulations of Biomedical Systems

Introduction to analytical modeling and computational simulations of systems. Examples will include cardio vascular, respiratory, muscle, neural and population models. Analytical models for several physiological systems will be studied, and simulations will be written in MATLAB. Fall - CREDIT: 4

BME270/470 - Biomedical Microscopy

This course covers the principles and practice of light microscopy as applied to biological and medical questions. Topics include basic light microscopy, epifluorescence, confocal and multiphoton laser-scanning microscopy, and selected methods such as CARS< FRET< FRAP< FCS, etc. This course is jointly listed as BME 470 for graduate students. Some homework problems are “BME470 only”. Prerequisites: OPT 241, OPT 261, BME201L, MTH 163/165, MTH 164 or permission of instructor. Fall – Taught alternate Fall semesters with OPT276 CREDITS: 4

BME274/474 Biomedical Sensors, Circuits & Interfacing

Course will cover circuits and sensors used to measure physiological systems at an advanced level. Both signal conditioning and sensor characteristics will be addressed. Topics will include measurement of strain, pressure, flow, temperature, biopotentials, and physical circuit construction. The co requisite Laboratory will focus on the practical implementation of electronic devices for biomedical measurements.

BME 283/483 - Biosolid Mechanics

Application of engineering mechanics to biological tissues including bone, soft tissue, cell membranes, and muscle. Realistic modeling of biological structures, including the heart, cells, and musculoskeletal joints. Experimental methods and material models. Prerequisites: ME226, BME 201, BME201L . Cross-listed: ME 483,. Semester Taught: Fall- CREDITS: 4

BME 295 - BME Design Seminar

Guided sessions for project development will be held, using brainstorming and other techniques, and then students will develop proposals and specifications for their projects. Presentations will be given describing all the proposed projects and students will be given an opportunity to turn in resumes to apply to work on projects of their choice. Students who wrote the proposals will select teams for the applicants, and final project execution will be carried out in the spring semester. Prerequisites: math, science, and engineering courses appropriate for fourth-year students in BME. Semester Taught: Fall - CREDITS: 2

BME 296 - BME Senior Design Project

Senior capstone design course in the Biomedical Engineering Program. Students work in teams to design, build, and test a medical device or instrument for a faculty, community or industrial sponsor. Accompanying lectures and discussions introduce issues related to ethics, economics, project management, regulation, safety, and reliability. Prerequisites: BME 295, Open only to Senior BME majors or permission of instructor Semester Taught: Spring - CREDITS: 4

BME 442 – Cell Motility and Molecular Machines

From single molecule motors transporting materials within cells to contracting muscle fibers, molecular engines come in a range of sizes and produce some of the most fascinating phenomena in biology. This course teaches the modern theories behind molecular engines, presuming only an elementary background in cell biology and mechanics. Prerequisites: permission of instructor. Semester Taught Second 1/2 of the Spring semester – CREDITS: 2

BME 448 - Principles of Eye Design

This course explores the design of the human eye, revealing the optical and neural factors that limit color and spatial vision. The design of eyes (such as those of predatory birds and the compound eyes of insects) that evolved to operate in environments different from that of the human eye are examined. The course begins with a treatment of the information losses associated with the eye's optics, the photoreceptor mosaic, and the ganglion cell array that transmits visual information to the brain. The course ends with a discussion of image processing by the visual cortex of the brain. Cross-listed: OPT 448/CVS492 –Taught alternate Spring semester CREDITS: 4

BME 452 - Medical Imaging-Theory & Implementation

Physics and implementation of X-ray, ultrasonic, and MR imaging systems. Special attention is given to the Fourier transform relations and reconstruction algorithms of X-ray and ultrasonic-computed tomography, and MRI. Prerequisites: ECE 242 Cross-listed: ECE 452. Semester Taught: Spring - CREDITS: 4

BME 453 - Advanced Biomedical Ultrasound

This course investigates the imaging techniques applied in state-of-the-art ultrasound imaging and their theoretical bases. Topics include linear acoustic systems, spatial impulse responses, the k-space formulation, methods of acoustic field calculation, dynamic focusing and apodization, scattering, the statistics of acoustic speckle, speckle correlation, compounding techniques, phase aberration correction, velocity estimation, and flow imaging. A strong emphasis is placed on readings of original sources and student assignments and projects based on realistic acoustic simulations. Prerequisites: BME 451 or permission of instructor. Semester Taught: Fall - CREDITS: 4

BME 468 - Industrial Microbiology

Consideration of microbiological and engineering aspects of industrial fermentations, bioreactors, sterilization and disinfection, sewage treatment, food processing and environmental problems. Lectures on genetic engineering, process energetics, and economics are complemented with laboratory exercises. Cross-listed: CHE468, MBI445 - CREDITS: 4

BME 469 - Biochemical Engineering

The engineering principles underlying the development and design of microbial and enzymatic systems for industrial processing. Emphasis is on integration of chemical engineering principles and life science fundamentals. Commercially significant examples are examined. Cross-listed: CHE469 - CREDITS: 4

BME 485 – Membrane Mechanics and Cell Adhesion

This course focuses on the fundamental science underlying the mechanical behavior of cell membranes and the formation of adhesive contacts between cells and between cells and substrates. Our approach is to explore mathematical descriptions of the physical properties biomembrane structures as well as the physics and chemical basis of cell adhesion. Basic aspects of the structure and composition of cell membranes and the classes of adhesion molecules found on cells are reviewed as a basis for the mathematical treatments. The course is typically taught in the first half of the spring semester. Prerequisites: This course is designed for upper level undergraduates and graduate students. Some background in mechanics and cell biology is desirable. Semester Taught first 1/2 of the semester Spring -CREDITS: 2

Appendix 2: example - BME CAREER PLANNING FORM

Department of Biomedical Engineering, University of Rochester

This form is designed to assist students in the development of a successful path to achieve their career goals. It is understood that your career plans will mature and clarify with time. However, it is important to begin to identify your career goals early so that you can amass the training and experience necessary for your success. Whatever your plans, there are a variety of resources available on campus to help you achieve your career goals and you should begin to explore these valuable resources.

Completion of this form is required for admission into the BME program. Students are encouraged to discuss their career plans with their BME faculty advisor when completing this form and throughout their academic career.

NAME:_____ Year:_____

BME Area of Concentration:_____

I. Briefly describe your career plans.

II. Do you have a current resume? Yes _____ No _____

The College Career Center, located in Meliora Hall, contains a wealth of resources to help you develop your resume and to begin planning your career. If you have not already visited The Career Center you should take advantage of their resources and opportunities soon. Visit The Career Center web site at http://www.rochester.edu/careercenter/

III. When you graduate from the UR with your B.S. in BME, you will be trained as a biomedical engineer with a specialty in the area of concentration indicated above. Please describe three examples of potential jobs that you would pursue with this training. [Please complete this exercise regardless of your response to Question I above.]

IV. Please list and describe any work or research experiences you have had, whether or not they are related to your career goals. If you have not had any related experiences yet, please describe your plans to obtain experience in your area of interest. Specifically, indicate what you have done or plan to do with your summers.

Work/Research Experiences or Plans.
Summer after Freshman Year.
Summer after Sophomore Year.
Summer after Junior Year.

V. Please indicate if you are planning to apply to any of the following programs in the future and answer the appropriate questions. **[Information on the following web sites may be useful in planning your timeline. http://www.bme.rochester.edu/undergrad/calendar/index.htm and http://www.rochester.edu/careercenter/]**

1. Take-5 Program Yes_____ No_____

If "Yes", when will you submit your application to this program? Semester_____ Yr ____

For information on Take-5 Program see http://www.rochester.edu/College/CCAS/TakeFiveSch.html

2. Industry Practicum Yes_____ No_____

If "Yes", what type of industry experience will you seek?

If "Yes", what semester/year do you plan on being away from the UR? _____

3. **Study Abroad Program** Yes_____ No_____
If "Yes", when will you submit your application to this program? Semester____ Yr ____
If "Yes", what semester/year do you plan on being away from the UR? _____
For information on the Study Abroad program
see http://www.rochester.edu/College/study-abroad/sa/index.html

4. **3-2 Program in BME at the UR** Yes_____ No_____
Applications for this program are due by April 1st of your junior year.

5. **A Masters in Business Administration (M.B.A) Program** Yes_____No_____
If "Yes", answer the following questions.
See http://www.rochester.edu/careercenter/students/grad/business.html
When will you take the GMAT? Month_____ Yr _____
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into a M.B.A. program? _____

6. **A graduate program leading to a Master's Degree** Yes_____ No_____
If "Yes", answer the following questions.
See http://www.rochester.edu/careercenter/students/grad/grad.html
In what area do you plan to obtain an M.S. degree? _____
When will you take the GRE? Month_____ Yr _____
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into a M.S. program? _____

7. **A graduate program leading to a Ph.D. degree** Yes_____ No_____
If "Yes", answer the following questions.
See http://www.rochester.edu/careercenter/students/grad/grad.html
In what area do you plan to obtain Ph.D. degree? _____
When will you take the GRE? Month_____ Yr _____
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into a Ph.D. program? _____
Do you have any research experience yet? Yes_____ No_____

8. **Medical School** Yes_____ No_____
If "Yes", answer the following questions.
See http://www.rochester.edu/careercenter/students/grad/med.html
Have you met with a UR pre-med advisor? Yes_____ No_____
When will you take the MCATs? Month_____ Yr _____
(See http://www.aamc.org/students/mcat/start.htm)
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into Medical School? _____
Do you have any experience in a clinical setting yet? Yes_____ No_____

9. **Dental School** Yes_____ No_____
If "Yes", answer the following questions.

Have you met with a UR pre-dental advisor? Yes_____ No_____
When will you take the DATs? Month_____ Yr _____
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into Dental School? _____
Do you have any experience in a dental setting yet? Yes_____ No_____

10. Law School Yes_____ No_____

If "Yes", answer the following questions.

See http://www.rochester.edu/careercenter/students/grad/law.html

Have you met with a UR pre-law advisor? Yes_____ No_____
When will you take the LSATs? Month_____ Yr _____
When will you submit your application to this program? Semester____ Yr ____
What do you think is a suitable GPA for acceptance into Law School? _____
Do you have any experience in a law setting yet? Yes_____ No_____

11. Other Program

Please describe your plans and your timeline

3/5/09 /daw

Appendix 3: BME CURRICULUM PLANNING FORM

BME students are required to maintain an up-to-date copy of this form in their advising folder, starting with the pre-registration that occurs in the spring of their second year. Additional copies of this form may be obtained from the BME Undergraduate Office - HPN206. Information on graduation requirements is provided on the reverse side.

NAME _____ ID# _____ DATE _____
CAMPUS
ADDRESS _____ EMAIL _____ CLASS _____

NOTE: Indicate in the extreme right column: TC=transfer credit, SR=summer course, AP=advanced placement

	Fall semester	Spring semester	Summer or Transfer
First year:	_____	_____	_____
_____	_____	_____	_____
Academic year	_____	_____	_____
	_____	_____	_____
Second year:	_____	_____	_____
_____	_____	_____	_____
Academic year	_____	_____	_____
	_____	_____	_____
Third year:	_____	_____	_____
_____	_____	_____	_____
Academic year	_____	_____	_____
	_____	_____	_____
Fourth year:	_____	_____	_____
_____	_____	_____	_____
Academic year	_____	_____	_____
	_____	_____	_____
If needed			
Fifth year:	_____	_____	_____
_____	_____	_____	_____
Academic year	_____	_____	_____

****

Advisor: _____ Date: _____
UG Coordinator reviewed for: _____ Date: _____