Department of Bioengineering
Undergraduate Handbook
2008 - 2009
University of Utah Department of Bioengineering

(Revision: November 10, 2007)

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The Department of Bioengineering offers a Bachelor of Science degree in Biomedical Engineering, as well as two programs for earning a combined BS/MS degree in Bioengineering. The Department also offers ME, MS, and PhD degrees (described elsewhere).

This handbook is intended to give information about policies and procedures for the undergraduate program in Biomedical Engineering. Please come to the Department office at 2750 Warnock Engineering Building, or email an advisor, if you have questions not answered here. The information in this handbook as well as various downloadable forms are also available online at *www.bioen.utah.edu*.

The University of Utah is committed to policies of equal opportunity, affirmative action, and nondiscrimination. The University seeks to provide equal access to its programs, services and activities for people with disabilities.

Contact Information and Links

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Department Web Site:	*www.bioen.utah.edu*		
See the site for links to:			
	Course Descriptions		
	Faculty Directory		
	Undergraduate Studies		
University of Utah Web Site:	www.utah.edu		
Biomedical Engineering Web Sites:			
	www.bmes.org		
	www.embs.org		

Contents

1 Program description

1.1 Mission

The mission of the Department of Bioengineering is to advance human understanding, health, and the quality of life through:

- internationally recognized research, discovery, and invention in the area of biomedical engineering;
- education of world-class Ph.D. scientists and engineers for accomplishment in research, academics, medicine, and industry;
- education of nationally-recognized B.S. and M.S. graduates for success and leadership in industry and in preparation for future study in medicine, science and engineering;
- transfer of scientific discoveries and biomedical technology to the private sector nationwide;
- delivery of high-quality M.E. continuing education to enhance the economy by supporting biomedical industries;
- training of students throughout the College of Engineering in bio-based solutions to traditional engineering problems and in the application of their specialty to biological and biomedical science.

1.2 Educational objectives

The department's educational objectives for the undergraduate BME program are:

- graduates will be successful in entering graduate programs, in gaining admission to professional schools including medical and law schools, or in obtaining employment in a biomedical engineering aligned industry;
- graduates will be able to solve problems at the interface of engineering and biology whether in a research environment, a clinical setting, or in industry;
- graduates will be motivated to pursue life-long learning efforts in order to fulfill their professional and ethical responsibility; and they will recognize their responsibility to understand contemporary questions at the interface of biomedical science, technology, and society;
- graduates will have noteworthy careers no matter what the direction or environment they chose because of their broad education founded in science and engineering.

1.3 Program outcomes

The department's Program Outcomes are:

- an ability to apply mathematics, science and engineering principles;
- an ability to conduct experiments and analyze and interpret data;
- an ability to design an experiment, system, component, or process to meet desired needs;
- an ability to function on multi-disciplinary teams;
- an ability to identify, formulate, and solve engineering problems;

- an understanding of professional ethical responsibility;
- an ability to communicate effectively in an oral format;
- an ability to communicate effectively in a written format;
- an understanding of the impact of engineering solutions in a global and societal context;
- an understanding of the need for and the ability to engage in lifelong learning;
- an understanding of contemporary issues;
- an ability to apply the techniques, skills, and modern engineering tools necessary for engineering practice.

2 Status and admissions

2.1 Pre-Major status

Students beginning the undergraduate program, including transfer students, should choose the Pre-Biomedical Engineering category as their major for registration purposes. Pre-major students are eligible to register for all classes listed in the freshman and sophomore years of the **Suggested Biomedical Engineering Plan of Study** in Section 4. Pre-majors are strongly encouraged to meet early with the Pre-Major Advisor in the Department to outline a course of study that will prepare them to apply for major status in a timely manner. Junior- and senior-year courses in the Biomedical Engineering program are open only to students with major status.

2.2 Admission to major status

Admission to major status in the Biomedical Engineering program is limited by the availability of Department teaching and laboratory resources and based solely on academic achievement. Approximately 50 applicants will be admitted to major status each year.

2.2.1 Regular admission

Normal admission to major status is based on a **specific grade point average made up of selected courses**. See Application Form at the end of this document and check with the Undergraduate Advisory in the Department office for details. In order to register for Department upper-division courses (3000-level or higher), a student **must have major status** (or receive permission from the Department and course instructor for exceptional circumstances).

To be considered for admission to major status, a student must have completed the following courses:

BIOEN 1101	Fundamentals of Bioengineering I
BIOEN 1102	Fundamentals of Bioengineering II
BIOEN 2000	Careers in Biomedical Engineering
BIOL 2020	Cell Biology (or equivalent)
CHEM 2310	Organic Chemistry I
CHEM 2315	Organic Chem Lab I
MATH 2250	Diff Eq/Lin Alg
PHYCS 2210	Physics for Scientists I

with an overall grade point average (GPA) in these classes of 3.0 or better. Combining this score with the overall University GPA (including transfer credit) leads to a composite GPA (as calculated on the application form) which must be 3.25 or higher for automatic admission. Students with a composite GPA below 3.25 but above 3.0 will join an admission waiting list.

2.2.2 Freshman admission

Starting in 2008, the program will also grant admission to a limited number of a freshman who show outstanding academic standing. Identification of these students will be based on entrance applications to the University and will occur automatically once students submit their applications. **There is no additional application required to the Department or the program.**

2.3 Scholarships

The Department, in cooperation with the College of Engineering, provides a limited number of scholarships to highly qualified applicants. Applications for scholarships are usually due on March 1. Contact the Department Office or see the Department web site for details.

3 Requirements for the B.S. Degree in BME

The undergraduate degree (B.S.) in Biomedical Engineering is granted upon successful completion of a minimum of 122 semester hours of the following requirements:

1. University's General Education Requirements,
2. Mathematics and Science,
3. the Biomedical Engineering Core, and
4. Track Electives.

These program requirements are described in detail below. Note that some of the requirements have changed from previous years and may continue to change.

Some of the General Education, mathematics and science courses may be waived for students who have AP credit from high school in those courses and who have achieved certain grades on the AP test. Details are in the www.ugs.utah.edu/catalog/ under the department offering the specific course.

3.1 General education requirements

See the website www.ugs.utah.edu/student/gened/index.htm for a description of the University's General Education requirements. General Education includes Intellectual Explorations courses (including a Diversity requirement), and the Writing, American Institutions, and Quantitative Reasoning course requirements.

Intellectual explorations Students must take two courses in each of the areas of Fine Arts, Humanities, and Social and Behavioral Science. The requirement in the Physical and Life Science area is automatically met by the Biomedical Engineering curriculum. One of the Intellectual Explorations courses selected should also meet the Diversity requirement. See the website www.ugs.utah.edu/student/gened/dv.htm for a description and list of Diversity courses. Note that not all of the classes that meet the Diversity criterion are also courses in the Intellectual Explorations lists. Students should try to take a Diversity course that will clear two requirements (Diversity and Intellectual Explorations) simultaneously.

Lower division writing Writing 2010 or the equivalent is required. The University's upper-division communication/writing requirement will automatically be met by successful completion of BIOEN 4202 (Bioengineering Project II) in the senior year.

American institutions See the website http://www.ugs.utah.edu/student/gened/ai.htm for courses that meet the American Institutions requirement. The American Institutions requirement may also be cleared by AP credit or by examination at the Testing Center in the Student Services Building during regular testing room hours.

Quantitative reasoning The Quantitative Reasoning and Quantitative Intensive course requirements (QA, QB, and QI) are met by the Biomedical Engineering curriculum through the calculus requirements and through BIOEN 5001 and BIOEN 5201 (Biophysics and Biomechanics).

3.2 Mathematics and Science

The following courses are required from the areas of mathematics and science:

MATH 1250	Calculus AP Students I
MATH 1260	Calculus AP Students II (or equivalent)
MATH 2250	Diff Eq/Lin Alg
PHYS 2210	Physics for Scientists I
PHYS 2220	Physics for Scientists II
CHEM 1210	General Chemistry I
CHEM 1215	General Chemistry Lab I
CHEM 1220	General Chemistry II
CHEM 1225	General Chemistry Lab II
CHEM 2310	Organic Chemistry I
CHEM 2315	Organic Chem Lab I
BIOL 2020	Cell Biology

All mathematics, science, and bioengineering core and technical elective courses should be taken for letter grade whenever this option is available.

3.3 Biomedical Engineering Core

The following 16 courses are required from the BME Core:

Premajor	
BIOEN 1101	Fundamentals of Bioengineering I
BIOEN 1102	Fundamentals of Bioengineering II
BIOEN 2000	Careers in Biomedical Engineering
Major	
BIOEN 3070	Statistics for Bioengineering*
BIOEN 3201	Bimolecular Engineering
BIOEN 3202	Physiology for Engineers
BIOEN 3301	Computation Methods for Bioengineers
BIOEN 3801	Biomedical Engineering Design I
BIOEN 4801	Biomedical Engineering Design II
BIOEN 4201	Biomedical Engineering Project I
BIOEN 4202	Biomedical Engineering Project II
BIOEN 5091	Current Research in Bioengineering
BIOEN 5001	Biophysics
BIOEN 5101	Bioinstrumentation
BIOEN 5201	Biomechanics
BIOEN 5301	Biomaterials

* It is possible to substitute another statistics class *e.g.,* Math 3070, for this requirement.

3.4 Tracks

The Biomedical Engineering program offers students an opportunity for specialization in the following areas:

Bioelectrical Engineering: based on course material from electrical engineering typically with a focus on instrumentation, imaging, or electrically based diagnostics and therapy.

Biomaterials Engineering: based on course material from materials science, material engineering, and mechanical engineering focused on the role of materials in biomedical applications.

Biomechanical Engineering: based on course material from physics or mechanical engineering focused on mechanical aspects of the body, mechanical characteristics of biomedical materials, fluids, use of heat and heat-inducing therapies, and prosthetics.

Biomolecular Engineering: based on course material from chemistry and chemical engineering and focused on the chemical characteristics of materials, biochemistry of living systems, and chemical based diagnostics and therapeutic drugs and materials

Computational Bioengineering: based on courses in computer science and mathematics and focused on the application of numerical and computational approaches to all aspects of the analysis, interpretation, visualization, and simulation of living systems.

Premedical Preparation: includes the required courses for entry to most medical and dental programs with an emphasis on clinical perspectives of engineering.

Special: for students with unique goals in their engineering degree; draws on courses from many engineering disciplines and the basic or medical sciences.

A student chooses an area based on his or her career goals and a discussion with the undergraduate advising in order to meet one or more of the following needs:

- Deeper knowledge of a particular field because of a pre-existing interest or focused career goals.
- Broader knowledge of a field in order to be prepared for a diverse career that has not yet focused on a particular aspect.
- Exploration of a wide variety of directions and courses in order to identify the most compelling and fulfilling future career directions.

The student then selects a set of courses consistent with the nature of the chosen track, which must be approved by the Program Directory. A student with special interests may design a spatial or customized track in consultation with the Department's Major Advisor.

Section 5 contains specific requirements and lists of approved track classes. Note that discussion and approval of the track electives must occur in discussion with the Major Advisory.

3.5 CO-OP/Internship Opportunities

Students interested in including industrial experience in their university education should consider participating in the Department's CO-OP/Internship Program. Internships can also lead to credit through BIOEN 4990, which can also be used as a track course (for 1 hour of credit). Contact Dr. Brenda Mann for more details (see website for contact information).

Note: BIOEN 4990 carried up to 3 hours of credit towards the degree but only **1 hour** of track course credit!!!

3.6 Continuing Performance

A student admitted to major status must maintain a cumulative University of Utah GPA, as reported on his or her transcript, above 3.00. Each course taken to satisfy departmental requirements in mathematics, chemistry, physics, biology, biomedical engineering core, and the track electives must be taken for credit and passed with a grade of C or better. **A student may repeat these technical courses only once, and the second grade received will be counted for the requirement.**

3.7 Leave of Absence

Students are expected to complete all degree requirements within four years of acceptance to major status. Students accepted into major status who are planning to be absent from the program for more than one year should request a leave of absence by submitting a letter to the Undergraduate Advisor. (A copy should also be sent to the University Admissions Office to avoid the necessity of reapplying for admission and repaying the admission fee upon return.)

Students who move to a part time status and do not take the normal course load should apply to the Major Advisor and a variance (tan colored form) and to work out an acceptable plan for continuing progress in the program.

Otherwise, students accepted into major status who are not making satisfactory progress may be dropped from the program and declared inactive. To be reinstated to active status, students must submit a written petition to the Director of Undergraduate Studies. Reinstated students matriculate under the latest graduation requirements.

3.8 Probation

A student admitted to major status whose cumulative GPA falls below 3.00 is placed on departmental academic probation and given written instructions for a return to good standing. Normally, these conditions must be met during the ensuing semester. Students who fail to meet probationary conditions are dropped from the program. Reinstatement requires a written petition to the Director of Undergraduate Studies. Reinstated students matriculate under the latest graduation requirements.

3.9 Repeat and Withdrawal Policies

The Biomedical Engineering program adheres to the College of Engineering policies for a course that is repeated and for withdrawals. In particular, a technical course required for the degree may be repeated only once, and the second grade received will be counted toward application for admission to major status and to the continuing performance requirement. Grades of W, I or V on the student's record count as having taken the class. This policy does not apply to courses taken to satisfy Intellectual Exploration and lower division Writing requirements.

3.10 Transfer Credit and Exceptions to Policy

Students wishing to apply credit from another school for any technical class which is not included in the College of Engineering Articulation Agreement (available on the University of Utah web site and in the Department of Bioengineering Office) must submit a Petition for Transfer Credit or Variance (the "tan sheet") along with thorough supporting documentation. Only after the petition has been approved by the Department will transfer technical credit by allowed toward completion of the BS degree in Biomedical Engineering. This applies even to classes that have been accepted by the University for general transfer credit; the classes must still be submitted for Departmental acceptance for transfer credit toward the degree by petition (unless they appear on the Articulation Agreement, in which case approval is automatic). Note that any exception to the Department's academic policies must be requested by submission of this same

form, and that such an exception is allowed only after the petition has been approved by the Department.

3.11 Exit Interviews and Graduation

In order to be cleared to graduate, a student **must meet with the Major Advisor** to review the DARS audit report and to verify that all graduation requirements will be completed by the time of graduation. This must be done one semester prior to graduation. Immediately prior to graduation, the student **must attend** an exit interview with a faculty member during a time announced in the senior classes. This exit interview provides important feedback to the Department to help improve the Biomedical Engineering program.

3.12 Undergraduate Advising

Please visit the Department of Bioengineering undergraduate office, 2750 Warnock Engineering Building, or call (801) 585-3651 for academic advice and information about the undergraduate program .

4 Suggested Biomedical Engineering Plan of Study

Below is a suggested plan of study. Items *in italics* indicate changes made for the 2008/09 entry (catalog) year.

Fall Semester			Spring Semester		
Course #	**Title**	**Hrs**	**Course #**	**Title**	**Hrs**
Freshman Year					
BIOEN 1101	Funds of Bioeng I	3	BIOEN 1102	Funds of Bioeng II	3
CHEM 1210	General Chemistry I	4	CHEM 1220	General Chemistry II	4
CHEM 1215	General Chemistry Lab I	1	CHEM 1225	General Chemistry Lab II	1
MATH 1250	Calculus AP Students I*	4	MATH 1260	Calculus AP Students II*	4
WRTG 2010	College Writing	3		Gen Ed Elective	3
Total		15			15
Sophomore Year					
BIOEN 2000	Careers in Biomed Eng	1	BIOEN 3201	Biomolecular Engineering	4
BIOL 2020	Cell Biology**	3	*BIOEN 3301*	*Computational Methods*	3
CHEM 2310	Organic Chemistry I	4	PHYCS 2220	Physics for Scientists II	4
PHYCS 2210	Physics for Scientists I	4		Gen Ed Elective	3
MATH 2250	Diff Eq/Lin Alg	3		Gen Ed Elective	3
CHEM 2315	Org. Chem I Lab	1			
Total		16			17
Junior Year					
BIOEN 3202	Physiology for Engineers	4	BIOEN 3801	BME Design I	3
BIOEN 5101	Bioinstrumentation	4	BIOEN 5001	Biophysics	4
*BIOEN 3070****	*Statistics for Eng*	3		Engineering Track	3
	Engineering Track	3		Engineering Track	3
BIOEN 5091	*Current Research in BME*	1		Gen Ed Elective	3
Total		15			16
Senior Year					
BIOEN 4801	BME Design II	3	BIOEN 4202	BME Project II	3
BIOEN 4201	BME Project I	2	BIOEN 5301	Biomaterials	4
BIOEN 5201	Biomechanics	4		Gen Ed Elective	3
	Engineering Track	3		Engineering Track	3
	Gen Ed Elective	3			
Total		15			13
Grand total					122

* As an alternative to this math sequence, students may take MATH 1270 and 1280 or the three-semester calculus series MATH 1210, 1220, and 2210.

** Students who have not had AP Biology in high school (with a score of 4 or 5) should take BIOL 1210 as a prerequisite to BIOL 2020.

*** MATH 3070 is accepted as a replacement for BIOEN 3070.

Descriptions of Bioengineering Department courses can be found at www.bioen.utah.edu/

5 Track Courses

Note: the number and criteria for track class have changed for the 2008/09 catalog year. Please note these changes if you have entered the program after September 1, 2007. The new requirements are as follows:

1. a minimum of **15** credit hours of course work, of which
2. at least **5** hours must be from courses taught in the College of Engineering and/or the College of Mines & Earth Sciences (ensures meeting ABET course requirements), and
3. at least **9** must be at the upper division level (3000 or above).

A student's track plan must be approved by the Department's Major Advisor by submitting a Track Coursework Plan (the "green sheet") available from the BE office, the Major Advisor or this link. Seeking approval for the track plan should occur in the first semester after admission to major status and before starting the track sequence. **Students who have not submitted a track sheet by the middle of the semester immediately following their admission will not be allowed to register for the following semester junior-year Bioengineering courses**.

5.1 Tips for planning track classes

- A list of Bioengineering Department courses suitable for inclusion in a track appears at the end of this section.
- Pay attention to prerequisites to be sure the courses are taken in the correct order.
- However, entry into upper division courses in other departments is often possible without the standard prerequisites for that department as long as the associated BME core course is completed. For example, to enter upper division classes in Mechanical Engineering, ensure that the BIOEN 5201, Biomechanics, is completed first (or concurrently). When in doubt, contact the Program Director for clarification or assistance.
- Organic Chemistry II and the Physics lab course required for entry to medical school are acceptable track classes.
- BIOEN 4990, Internship, will receive only 1 hour of track credit, even when it contributes additional hours to the program of study.
- Directed reading, independent study, literature surveys, and special project classes do not generally qualify as track classes. Exceptions are possible but the Program Director must approve these **beforehand**.
- Some seminar classes (*e.g.,* BIOEN 6480, BIOEN 6464) may be acceptable for 1 hour of track credit, but only when they are used only to ensure adequate college credit hours, *i.e.,* they are not counted as part of the minimum 15 hours.

Below are some samples of course selections organized by track. Note that in many cases, Bioengineering students can progress directly to the upper division classes offered by other departments **without completing the usual requirements** for those classes. When in doubt, the Major Advisor or the instructor of the course can provide guidance.

Prerequisites Note that there are prerequisites for many of these courses and that to have the most choice of courses, it is important to take these prerequisites as early as possible. Direct entry into most upper division classes is permitted as long as the associated BME core class is complete, *e.g.,* Biomechanics for upper division classes in Mechanical Engineering.

5.2 Bioelectrical Engineering Track

BIOEN 5401	Medical Imaging Systems
BIOEN 5460	Engineering Aspects of Clinical Medicine
BIOEN 5480	Ultrasound
BIOEN 6330	Principles of Magnetic Resonance Imaging
BIOEN 6410	Bioinstrumentation: Biosignals and Biosensors
BIOEN 6421	Fundamentals of Micromachining Processes
BIOEN 6500	Mathematics of Imaging
BIOEN 6640	Introduction to Image Processing
ECE 2260	Fundamentals of Electric Circuits
ECE 2280	Fundamentals of Engineering Electronics
ECE 3110	Engineering Electronics II
ECE 3300	Fundamentals of Electromagnetics and Transmission Lines
ECE 3500	Fundamentals of Signals and Systems
ECE 3510	Introduction to Feedback Systems
ECE 5325	Wireless Communication Systems
ECE 5340	Numerical Techniques in Electromagnetics
ECE 5410	Lasers and Their Applications
ECE 5530	Digital Signal Processing

5.3 Biomaterials Engineering Track

MSE 2010	Introduction to Materials Science & Engineering
MSE 3010	Materials Processing Laboratory
MSE 3310	Introduction to Ceramics
MSE 3011	Structural Analysis of Materials
MSE 3210	Electronic Properties of Solids
MSE 3310	Introduction to Ceramics
MSE 3410	Introduction to Polymers
MSE 3510	Introduction to Metallic Materials
MSE 5010	X-ray Diffraction Techniques
MSE 5035	Electron Microscopy Techniques
MSE 5061	Transport Phenomena in Materials Science and Engineering
MSE 5201	Semiconductor Device Physics I
MSE 5202	Semiconductor Device Physics II
MSE 5211	Semiconductor Device Fabrication Laboratory I
MSE 5212	Semiconductor Device Fabrication Laboratory II
MSE 5240	Principles and Practice of Transmission Electron Microscopy
MSE 5353	Physical Ceramics
MSE 5354	Processing of Advanced Ceramics
MSE 5471	Polymer Processing
MSE 5473	Polymer Synthesis and Characterization
MSE 5475	Introduction to Composites
ME EN 1300	Statics and Strength of Materials
MET E 1620	Introduction to Physical Metallurgy
MET E 3530	Experimental Techniques in Metallurgy
MET E 5260	Physical Metallurgy I
MET E 5450	Mechanical Metallurgy
MET E 5600	Corrosion Engineering

5.4 Biomechanical Engineering Track

BIOEN 6230	Functional Anatomy for Engineers
BIOEN 6421	Fundamentals of Micromachining
BIOEN 7210	Biosolid Mechanics
BIOEN 7220	Biofluid Mechanics
ME EN 1300	Statics and Strength
ME EN 2080	Dynamics
ME EN 2300	Thermodynamics I
ME EN 2450	Numerical Techniques in Engineering
ME EN 3300	Strength of Materials
ME EN 3650	Heat Transfer
ME EN 3700	Fluid Mechanics
ME EN 5300	Advanced Strength of Materials
ME EN 5500	Engineering Elasticity
ME EN 5510	Introduction to Finite Elements
ME EN 5520	Composites
ME EN 5720	Comp. Fluid Mechanics

5.5 Biomolecular Engineering Track

BIOEN 5090	Biophysical Chemistry
BIOEN 6002	Molecular Biophysics
BIOEN 6140	Fundamentals of Tissue Engineering
BIOEN 6421	Fundamentals of Micromachining Processes
BIOEN 6505	Biotransport Phenomena
BIOEN 7111	Physicochemical Approach to Proteins and Nucleic Acids
BIOEN 7120	Biocompatibility
BIOEN 7140	Advanced Topics in Tissue Engineering
BIOL 2030	Genetics
BIOL 3215	Cell Biology Laboratory
BIOL 3230	Developmental Biology
CH EN 5103	Biochemical Engineering
CH EN 5104	Biochemical Engineering Laboratory
CHEM 3510	Biological Chemistry I
CHEM 3515	Biological Chemistry Laboratory
CHEM 3520	Biological Chemistry II
CHEM 3525	Molecular Biology of DNA Lab
CHEM 5810	Nanoscience: Where Biology, Chemistry and Physics Intersect
MSE 2010	Introduction to Materials Science & Engineering
MSE 3410	Introduction to Polymers
MSE 5010	X-ray Diffraction Techniques
MSE 5035	Electron Microscopy Techniques
MSE 5061	Transport Phenomena in Materials Science and Engineering
PATH 5030	Basic Immunology

5.6 Computational Bioengineering Track

BIOEN 6500	Mathematics of Imaging
BIOEN 6640	Introduction to Image Processing
BIOEN 6760	Modeling and Analysis of Biological Network
BIOEN 7320	3-D Reconstruction Techniques in Medical Imaging
CS 1010	Introduction to Unix
CS 2000	Introduction to Programming in C
CS 2010	Discrete Structures
CS 3200	Scientific Computation
CS 3500	Software Practice I
CS 3505	Software Practice II
CS 3700	Fundamentals of Digital System Design
CS 4100	Advanced Algorithms and Data Structures
CS 5300	Artificial Intelligence
CS 5310	Robotics
CS 5320	Computer Vision
CS 5530	Database Systems
CS 5540	Human/Computer Interaction
CS 5600	Introduction to Computer Graphics
CS 5610	Interactive Computer Graphics
CS 5630	Scientific Visualization
CS 6210	Advanced Scientific Computing I
CS 6220	Advanced Scientific Computing II
ECE 3700	Fundamentals of Digital System Design
ECE 5340	Numerical Techniques in Electromagnetics
CH EN 3510	Introduction to Metallic Materials
CH EN 5353	Computational Fluid Dynamics
CH EN 6703	Applied Numerical Methods
MATH 5110	Mathematical Biology I
MATH 5120	Mathematical Biology II
MATH 5600	Survey Numerical Analysis
MATH 5610	Intr. Numerical Analysis I
MATH 5740	Mathematical Modeling
ME EN 5510	Introduction to Finite Elements

5.7 Premedical Track

Students planning on applying to medical school may wish to design a track that supports this goal. The track courses selected should meet, to the extent possible, three criteria:

1. They complete course requirements set by the medical schools for admission;
2. They are from a subject area in which the student does well;
3. They provide the student a sound foundation for an alternative career choice should the medical schools not respond favorably.

The BS program in Biomedical Engineering generally meets all the course requirements for medical school with the possible exception of Organic Chemistry II (lecture and laboratory) and laboratories in introductory courses in Biology and Physics. However, the Biomedical Engineering core courses taken in

the junior and senior years supply laboratory course hours which may be accepted in lieu of these explicit laboratory courses. Some medical schools also require an upper division writing course, *i.e.,* they do not accept the Senior Project classes as equivalent.

Because there is considerable variability in what is both recommended and required among different medical schools, students should review the entrance requirements of the medical schools to which they are considering applying and determine which of the following courses to include in their tracks.

BIOEN 5090	Biophysical Chemistry
BIOEN 5401	Medical Imaging Systems
BIOEN 5460	Engineering Aspects of Clinical Medicine
BIOEN 5480	Ultrasound
BIOEN 6000	Systems Physiology I: Cardiovascular System
BIOEN 6010	Systems Physiology II: Nervous/Endocrine Systems
BIOEN 6140	Fundamentals of Tissue Engineering
BIOEN 6230	Functional Anatomy for Engineers
BIOL 2030	Genetics
BIOL 3215	Cell Biology Lab
BIOL 3230	Developmental Biology
BIOL 3510	Biological Chemistry I
BIOL 3515	Biological Chemistry Lab
BIOL 3520	Biological Chemistry II
PATH 5030	Basic Immunology

5.8 Department of Bioengineering courses approved for inclusion in BME tracks

The following courses are all recommended and approved for inclusion in the track plan for Biomedical Engineering. This course list is changing constantly and course offerings change in other departments so please consult with the Major Advisor whenever making a decision on the track plan. **It is up to the individual student to ensure that the courses in the track exist and are offered at the time the student wishes to take them. Note that many courses are taught only every second year.**

BIOEN 5090	Biophysical Chemistry
BIOEN 5401	Medical Imaging Systems
BIOEN 5460	Engineering Aspects of Clinical Medicine
BIOEN 5480	Ultrasound
BIOEN 4990	Internships and Cooperative Education (1 Credit Hour)
BIOEN 6000	Systems Physiology I: Cardiovascular System
BIOEN 6010	Systems Physiology II: Nervous/Endocrine Systems
BIOEN 6002	Molecular Biophysics
BIOEN 6003	Cellular Electrophysiology and Biophysics
BIOEN 6050	Cellular Physiology for Engineers
BIOEN 6080	Ideas Into Dollars: Writing Grant Proposals
BIOEN 6140	Fundamentals of Tissue Engineering
BIOEN 6230	Functional Anatomy for Engineers
BIOEN 6310	Physics of MEG, X-Ray and Ultrasound
BIOEN 6320	Physics of Nuclear Medicine and MRI
BIOEN 6330	Principles of Magnetic Resonance Imaging
BIOEN 6410	Bioinstrumentation
BIOEN 6421	Fundamentals of Micromachining Processes
BIOEN 6422	Biomedical Applications of Micromachining
BIOEN 6430	Systems Neuroscience
BIOEN 6433	Biological Statistical Signal Processing
BIOEN 6440	Neural Engineering
BIOEN 6450	Bioengineering Control Systems
BIOEN 6460	Electrophysiology and Bioelectricity
BIOEN 7111	Physicochemical Approach to Proteins and Nucleic Acids
BIOEN 7120	Biocompatibility
BIOEN 7130	Pharmaceutical Applications of Colloid and Interfacial Science
BIOEN 7140	Advanced Topics in Tissue Engineering
BIOEN 7150	Introduction to Biomimetic Engineering
BIOEN 7155	Neural Interfaces Laboratory
BIOEN 7160	Physical Nature of Surfaces
BIOEN 7168	Proteins at Interfaces and in Membranes
BIOEN 7210	Biosolid Mechanics
BIOEN 7220	Biofluid Mechanics
BIOEN 7310	Advanced Topics in Magnetic Resonance Imaging
BIOEN 7320	3D Reconstruction Techniques in Medical Imaging
BIOEN 7410	Advanced Bioinstrumentation
BIOEN 7420	Modeling of Physiological Systems

5.9 Courses NOT acceptable for inclusion as a track elective

The following courses are not acceptable as a track elective for the Biomedical Engineering program. The reasons for excluding courses include:

- course does not include adequate engineering or biomedical content;
- course overlaps too much with a course already in the core curriculum of the BME program;
- course level, requirements, or evaluation are not equivalent to the rest of the BME program;
- course does not require active participation of the student

BE 4999	Honors Thesis/Project
BE 5020	Interactive Science Exhibits
BE 5950/6910	Independent Study
BE 6090/1	Department Seminar
BE 6062	Biomedical Engineering Literature Survey
BE 6480	Biomechanics Seminar*
BE 6464	Cardiac Electrophysiology and Biophysics Seminar*
BE 6900	Special Topics**
BE 6930	Special Project
MSE 2160	Elements of Materials Science and Engineering Take MSE 2010 instead (Introduction to Materials Science & Engineering)
MSE 2170	Elements of Materials Science and Engineering Take MSE 2010 instead (Introduction to Materials Science & Engineering)
PHYS 3110	Physics of the Human Body I
PHYS 3111	Physics of the Human Body II

* students may take these courses for track credit only if they otherwise have adequate numbers of hours but need to achieve the required number of college hours.

** Special topics class may count for track electives depending on the type and structure of the course. Please see the Major Advisor **before** taking a special topics class to determine its status.

6 Senior Project

A major component of the undergraduate program is the senior project, which involves two components:

1. A substantial involvement (approximately 200 hours) in one of three activities:
   - A scientific research project supervised by a faculty member either in or affiliated with the Bioengineering Department.
   - A design project that extends above and beyond the scope of the Bioengineering Design Course, mentored by a Bioengineering faculty member.
   - A substantial design or research project undertaken as part of an industrial or academic internship.
2. Completing the Senior Project class (BE 4201 and BE 4202).

The goals of the senior project are to develop specific experience and skills in scientific research and/or engineering design and development and to learn to present the results of such a study in all forms: written, oral, and visual. For most students, the senior project should be the culminating activity of their program in

which they use skills acquired from numerous courses and previous laboratories and develop a whole new set of abilities in the science (and art) of organizing and presenting ideas.

Success in the senior project requires taking the following steps:

1. As the very latest in the spring of the Junior year, obtain a placement in a research lab, with a biomedical engineering form, or in a lab related to the design class project.
2. Discuss with a mentor the specific needs of the senior project and develop a plan to carry out a project of adequate scope to generate the results for the senior project.
3. Make sure that by the **beginning of the fall semester** in the Senior year, there are enough results/data to write and talk about in the Senior Project class BE 4201.

If there are questions or uncertainty at any step in the process, the Major Advisor will be available to help.

7 B.S./M.S. Program

The Department offers for students interested in rapidly advancing to the Master's level a combined B.S./M.S. program. The program is described in a separate document on the Department website and students interested in the program should read this description carefully to ensure that their course of study complies with the requirements.

Note that international students on visas are not eligible to participate in the combined BS/MS programs, per SEVIS regulations according to the U.S. Immigration and Customs Enforcement (URL: www.ice.gov/sevis).

Department of Bioengineering
Application for Admission to Major Status in Biomedical Engineering

Instructions: In order to earn a Bachelor of Science degree in Biomedical Engineering, you must be admitted to major status before registering for any upper level Biomedical Engineering classes. To be considered for admission to major status requires, as a minimum, completion of the courses listed below with a grade point average of 3.00 or better. You may repeat technical courses only once, and the second grade received will be counted for the requirement. Actual admission is based on the composite GPA as calculated on this form. Students with composite GPAs of 3.25 or higher will be automatically admitted to major status; students with composite GPAs below 3.25 but above 3.0 will be placed on a wait list and admitted as space permits at the end of the next summer session. Target enrollment is 50 students.

To apply for admission to major status, submit this application form, an ***official*** copy of your University of Utah transcript and a summary of transfer credits (if applicable) to the Undergraduate Secretary any time during the academic year but no later than one day after the posting of grades for the previous summer session. Applications for admission will be considered as they are received. Students admitted to major status before the beginning of spring semester may start taking major classes that semester.

Name: _____ Student No. _____

Address: _____ Phone: _____

_____ Email: _____

Course *(Example*		**Letter Grade** *A-*	**Grade Value** *3.70*	**x** *x*	**Credit Hours** *3*	**=** *=*	**Points** *11.10*	**Semester/Year Taken** *Fall 02)*
BIOEN 2000	Careers in Biomedical Engineering	_____	**N/A**		**N/A**		**N/A**	_____
BIOEN 1101	Fund. of Bioengineering I	_____	_____	x	3	=	_____	_____
BIOEN 1102	Fund. of Bioengineering II	_____	_____	x	3	=	_____	_____
BIOL 2020	Cell Biology	_____	_____	x	3	=	_____	_____
CHEM 2310	Organic Chemistry I	_____	_____	x	4	=	_____	_____
CHEM 2315	Organic Chemistry Lab I	_____	_____	x	1	=	_____	_____
MATH 2250	Diff. Equations & Linear Algebra	_____	_____	x	3	=	_____	_____
PHYCS 2210	Physics for Scientist & Engineers I	_____	_____	x	4	=	_____	_____
	Total				**21**		_____	

* Grade Values: A = 4.00, A- = 3.70, B+ = 3.30, B = 3.00, B- = 2.70, C+ 2.30, C=2.00

A GPA from courses above (Total Points / Total Credit Hours): _____

B U of U Cumulative GPA reported on transcript (adjusted to include transfer grades weighted by hrs.): _____

C Composite GPA: (0.50 x **A** + 0.50 x **B**): _____

Student Signature: _____ Date: _____

Office use
Confirmed: _____

Action date(s): _____ *Admit* _____ *Wait list* _____ *Decline*

2008

Department of Bioengineering

Track Coursework Plan (2008)

Name: _____ Student No: _____

Address: _____

Phone number: _____ email address: _____

Indicate one of these areas that best describes your track:

- ☐ Bioelectrical Engineering
- ☐ Biomechanical Engineering
- ☐ Computational Bioengineering
- ☐ Special
- ☐ Biomaterials Engineering
- ☐ Biomolecular Engineering
- ☐ Premed

List below a set of courses that is consistent with meeting your career goals. The plan must be well-thought out and coherent in terms of these goals. Examples of possible track courses are given in the Undergraduate Handbook.

Each of the courses listed below must be in the area of science or engineering. They must total 15 or more credit hours. At least 5 of the hours must be from the College of Engineering and/or the College of Mines & Earth Sciences. At least 9 of the hours must be at the 3000 level or above.

Consult with the Bioengineering Department's Major Advisor in planning your track. Submit this completed form to the Department's Major Advisor for approval before taking courses toward the track requirements. Any subsequent changes to your plan must also be approved using this form.

Course Number	Course Title	Credit Hrs	Semester/Yr

Student Signature: _____

Department Approval: _____ Date: _____