DOCUMENTS OF THE GENERAL FACULTY

PROPOSED CHANGES TO THE BIOMEDICAL ENGINEERING DEGREE PROGRAM IN THE COCKRELL SCHOOL OF ENGINEERING CHAPTER IN THE *UNDERGRADUATE CATALOG 2018-2020*

Dean Sharon L. Wood in the Cockrell School of Engineering has filed with the Secretary of the Faculty Council the following proposal to change the Biomedical Engineering degree program in the Cockrell School of Engineering chapter in the *Undergraduate Catalog, 2018-2020*. The Biomedical Engineering faculty approved the proposal on April 27, 2107; the Degrees and Courses Committee approved it on May 24, 2017; the Dean and the College faculty approved it on September 18, 2017. The Secretary has classified this proposal as legislation of exclusive interest to one college or school.

The Committee on Undergraduate Degree Program Review recommended approval of the proposal on December 5, 2017, and forwarded it to the Office of the General Faculty. The Faculty Council has the authority to approve this legislation on behalf of the General Faculty. The authority to grant final approval on this legislation resides with the Provost on behalf of the President.

If no objection is filed with the Office of the General Faculty by the date specified below, the legislation will be held to have been approved by the Faculty Council. If an objection is filed within the prescribed period, the legislation will be presented to the Faculty Council at its next meeting. The objection, with reasons, must be signed by a member of the Faculty Council.

To be counted, a protest must be received in the Office of the General Faculty by December 12, 2017.

Alan W. Friedman

Alan W. Friedman, Secretary of the General Faculty and Faculty Council
The University of Texas at Austin
Arthur J. Thaman and Wilhelmina Doré Thaman Professor of English and Comparative Literature

Distributed through the Faculty Council Wiki site https://wikis.utexas.edu/display/facultycouncil/Wiki+Home on December 6, 2017.

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PROPOSED CHANGES TO THE BIOMEDICAL ENGINEERING DEGREE PROGRAM IN THE COCKRELL SCHOOL OF ENGINEERING CHAPTER IN THE *UNDERGRADUATE CATALOG 2018-2020*

TYPE OF CHANGE: ☒ Academic Change
☐ Degree Program Change (THECB form required)

PROPOSED CLASSIFICATION: ☒ Exclusive ☐ General ☐ Major

1. **IF THE ANSWER TO ANY OF THE FOLLOWING QUESTIONS IS YES, THE COLLEGE MUST CONSULT LINDA DICKENS, DIRECTOR OF ACCREDITATION AND ASSESSMENT, TO DETERMINE IF SACSCOC APPROVAL IS REQUIRED.**
   - Is this a new degree program? Yes ☐ No ☒
   - Is this program being deleted? Yes ☐ No ☒
   - Does the program offer courses that will be taught off campus? Yes ☐ No ☒
   - Will courses in this program be delivered electronically? Yes ☐ No ☒

2. **EXPLAIN CHANGE TO DEGREE PROGRAM AND GIVE A DETAILED RATIONALE FOR EACH INDIVIDUAL CHANGE:**
   The following bulleted list describes each change made to the degree program document attached, with corresponding page numbers in parentheses. The changes in the degree plan for 2018-20 catalog are entirely focused on providing more options in the technical area elective requirements, with the exception of a few stylistic edits in the first few pages. No changes are proposed to courses required for all students in the major, and no changes are proposed to add requirements from outside of Biomedical Engineering. The rationale is to provide more technical elective options within Biomedical Engineering in order for students to complete the twelve semester credit hours of technical electives, and gain deeper knowledge and skills in technical areas that interest them and will prepare them for their chosen career tracks.
   - **Portable Computing Devices:** *Minor grammatical and style editing*.
   - **List of course requirements:**
     - **M 427J -** Math department has changed M427K to M427J, this change therefore reflects college-wide changes in course number.
     - **UGS 302 and 303 -** Clarification of writing flag options for sections of first-year signature courses.
   - **Technical Area Options:**
     - **Introduction -** Addition of statement to require a minimum of six semester credit hours counting toward the twelve semester credit hours required for technical area electives must be taken in engineering, in response to fall 2016 ABET accreditor feedback. This statement is reiterated under each of the four areas as well.
     - **Preparation for health professions -** Minor style editing for consistency.
     - **Preparation for law -** Minor edits for consistency and to provide links to more information.
     - **Minors and certificate programs -** Minor style edits for consistency.
   - **Technical Area 1, Biomedical Imaging and Instrumentation:**
     - **Introduction -** Addition of statement to require a minimum of six semester credit hours counting toward the twelve semester credit hours required for technical area electives must be taken in engineering, in response to fall 2016 ABET accreditor feedback.
     - **BME 350 addition -** Newly developed technical elective added to the list of BME options that count toward the requirement.
     - **BME 358 addition -** Technical elective added to the list of BME options that count toward the requirement.
   - **Technical Area 2, Cellular and Biomolecular Engineering**
     - **Introduction -** Addition of statement to require a minimum of six semester credit hours counting toward the twelve semester credit hours required for technical area electives must be taken in engineering, in response to fall 2016 ABET accreditor feedback.
     - **Career Emphasis A: Biomaterials/Regenerative Medicine**

- **BME 359 addition -** Technical elective added to the list of BME options that count toward the technical area requirement in the Biomaterials/Regenerative Medicine career emphasis.
- **BME 366 addition -** Newly developed technical elective added to the list of BME options that count toward the technical area requirement in the Biomaterials/Regenerative Medicine career emphasis.
- **BME 373 addition -** Newly developed technical elective added to the list of BME options that count toward the technical area requirement in the Biomaterials/Regenerative Medicine career emphasis.
- **BME 375 addition -** Newly developed technical elective added to the list of BME options that count toward the technical area requirement in the Biomaterials/Regenerative Medicine career emphasis.

- **Career Emphasis B: Nanotechnology**
  - **BME 359 addition -** Technical elective added to the list of BME options that count toward the technical area requirement in the Nanotechnology career emphasis.
  - **CHE 322 removal -** Removal of elective option due to overlap in content with other new BME courses.

- **Technical Area 3, Computational Biomedical Engineering**
  - **Introduction -** Addition of statement to require a minimum of six semester credit hours counting toward the twelve semester credit hours required for technical area electives must be taken in engineering, in response to fall 2016 ABET accreditor feedback.
  - **BME 347 addition -** Technical elective added to the list of BME options that count toward the technical area requirement.
  - **BME 350 addition -** Newly developed technical elective added to the list of BME options that count toward the technical area requirement.
  - **BME 357 addition -** Technical elective added to the list of BME options that count toward the technical area requirement.
- **Technical Area 4, Biomechanics**
  - **Introduction -** Addition of statement to require a minimum of six semester credit hours counting toward the twelve semester credit hours required for technical area electives must be taken in engineering, in response to fall 2016 ABET accreditor feedback.
  - **BME 354 addition -** Technical elective added to the list of BME options that count toward the technical area requirement.
  - **BME 373 addition -** Newly developed technical elective added to the list of BME options that count toward the technical area requirement.
  - **ME 314D edit -** Mechanical Engineering has changed the course number for this course from 324 to 314D.
  - **ME 326 removal -** Removal of elective option due to overlap in content with other new BME courses.
- **Suggested arrangement of courses -** Math department has changed M427K to M427J, this change therefore reflects college-wide changes in course number.

3. THIS PROPOSAL INVOLVES: (Please check all that apply)

☐ Courses in other colleges	☐ Courses in proposer's college that are frequently taken by students in other colleges	☐ Flags
☐ Course in the core curriculum	☐ Change in course sequencing for an existing program	☒ Courses that have to be added to the inventory
☐ Change in admission requirements (external or internal)	☐ Requirements not explicit in the catalog language (e.g., lists of acceptable courses maintained by department office)	

4. SCOPE OF PROPOSED CHANGE:

a. Does this proposal impact other colleges/schools? Yes ☐ No ☒
If yes, then how would you do so?

b. Do you anticipate a net change in the number of students in your college? Yes ☐ No ☒
If yes, how many more (or fewer) students do you expect?

c. Do you anticipate a net increase (or decrease) in the number of students from outside of your college taking classes in your college? Yes ☐ No ☒
If yes, please indicate the number of students and/or class seats involved.

d. Do you anticipate a net increase (or decrease) in the number of students from your college taking courses in other colleges? Yes ☐ No ☒
If yes, please indicate the number of students and/or class seats involved.

If 4 a, b, c, or d was answered with yes, please answer the following questions:
If the proposal has potential budgetary impacts for another college/school, such as requiring new sections or a non-negligible increase in the number of seats offered, at least one contact must be at the college-level.

How many students do you expect to be impacted?
Impacted schools must be contacted and their response(s) included:
Person communicated with:
Date of communication:
Response:

e. Does this proposal involve changes to the core curriculum or other basic education requirements (42-hour core, signature courses, flags)? If yes, explain:
If yes, Undergraduate Studies must be informed of the proposed changes and their response included:
Person communicated with:
Date of communication:
Response:

f. Will this proposal change the number of hours required for degree completion?
Note: THECB Semester Credit Hour Change Form required, download from URL:
http://www.thecb.state.tx.us/reports/DocFetch.cfm?DocID=2419&format=doc
If yes, explain:

5. COLLEGE/SCHOOL APPROVAL PROCESS

Department approval date:	April 27, 2017	Biomedical Engineering Faculty
College approval date:	May 24, 2017	CSE Degrees & Courses Committee
Dean approval date:	Sept. 18, 2017	CSE Faculty: Sharon L. Wood, Dean

PROPOSED NEW CATALOG TEXT:

BACHELOR OF SCIENCE IN BIOMEDICAL ENGINEERING

The mission of the Department of Biomedical Engineering is to develop clinically translatable solutions for human health by training the next generation of biomedical engineers, cultivating leaders, and nurturing the integration of science, engineering, and medicine in a discovery-centered environment. The main educational objective is to provide a thorough training in the fundamentals of engineering science, design, and biology. The curriculum is designed to provide concepts central to understanding living systems from the molecular and cellular levels to the tissue and organismal levels. The curriculum incorporates principles of vertical integration, leading to the choice of a technical area (biomedical imaging and instrumentation, cellular and biomolecular engineering, computational biomedical engineering, or biomechanics), and culminates in a team capstone design experience. Students are expected to develop an understanding of industrial, research, and clinical biomedical engineering environments; an understanding of regulatory issues and biomedical ethics; the ability to create, identify, formulate, and solve biomedical engineering problems; the ability to design systems to meet needs in medical/life science applications; an understanding of life processes at the molecular, cellular, tissue, and organismal levels; the ability to use instrumentation and to make measurements and interpret data in living systems; and an appreciation of the interdisciplinary nature of biomedical engineering research.

Portable Computing Devices

Students entering biomedical engineering are required to have a laptop computer [~~at their disposal~~]. Laptops do not need to be brought to campus on a daily basis, but individual courses may require that a laptop be brought to certain lectures, labs, and/or exams. Minimum requirements for the laptop are listed on the department's website.

Student Outcomes

Graduates of the biomedical engineering program are expected to have:

a. An ability to apply knowledge of mathematics, science, and engineering
b. An ability to design and conduct experiments, as well as to analyze and interpret data
c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. An ability to function on multidisciplinary teams
e. An ability to identify, formulate, and solve engineering problems
f. An understanding of professional and ethical responsibility
g. An ability to communicate effectively
h. The broad education necessary to understand what impact engineering solutions have in global, economic, environmental, and societal contexts
i. A recognition of the need for and an ability to engage in lifelong learning
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Program Educational Objectives

Achievement of the preceding program outcomes gives students the foundation for accomplishing the biomedical engineering program educational objectives. A few years after graduation, students are expected to be able to:

1. Conduct themselves with exemplary professional ethics and highest integrity
2. Demonstrate a quantitative, analytical, and systems approach to problem solving in their professional practice
3. Demonstrate a continuous quest for professional excellence and success
4. Participate in continuing education to expand their knowledge of contemporary professional issues
5. Exhibit effective scientific, technical, communication, and resource management skills in their professional practice

Curriculum

Course requirements include courses within the Cockrell School of Engineering, and other required courses. In addition, each student must complete the University's core curriculum. In some cases, a course that fulfills one of the following requirements may also be counted toward core curriculum or flag requirements; these courses are identified below.

In the process of fulfilling engineering degree requirements, students must also complete coursework to satisfy the following flag requirements: one independent inquiry flag, one quantitative reasoning flag, one ethics and leadership flag, one global cultures flag, one cultural diversity in the United States flag, and two writing flags. The independent inquiry flag, the quantitative reasoning flag, the ethics and leadership flag, and the two writing flags are carried by courses specifically required for the degree; these courses are identified below. Courses that may be used to fulfill flag requirements are identified in the Course Schedule.

Prior to registration, students must receive approval from the Biomedical Engineering Academic Advising Office for courses to be used to fulfill technical and nontechnical course requirements. The student must take all courses required for the degree on the letter-grade basis and must earn a grade of at least C- in each, except for those listed as Remaining Core Curriculum Courses.

Requirements		Hours
Biomedical Engineering Courses		
BME 214L	Computational Fundamentals of Biomedical Engineering Design	2
BME 245L	Experimental Principles of Biomedical Engineering Design	2
BME 261L	Development and Analysis in Biomedical Engineering Design	2
BME 303	Introduction to Computing	3
BME 303L	Introduction to Biomedical Engineering Design	3
BME 311	Network Analysis in Biomedical Engineering	3
BME 313L	Introduction to Numerical Methods in Biomedical Engineering	3
BME 333T	Engineering Communication (writing and an ethics and leadership flag)	3
BME 335	Engineering Probability and Statistics	3
BME 343	Biomedical Engineering Signal and Systems Analysis	3
BME 344	Biomechanics	3
BME 349	Biomedical Instrumentation	3
BME 352	Engineering Biomaterials	3
BME 353	Transport Phenomena in Living Systems	3
BME 355	Molecular Engineering	3
BME 365R	Quantitative Engineering Physiology I	3
BME 365S	Quantitative Engineering Physiology II	3
BME 370	Biomedical Engineering Capstone Design I (writing flag)	3
BME 371	Biomedical Engineering Capstone Design II (independent inquiry flag)	3
Approved technical area elective		12
Biology		
BIO 206L	Introductory Laboratory Experiments in Biology	2
BIO 311C	Introductory Biology I	3
Biochemistry and Chemistry		
BCH 369	Fundamentals of Biochemistry	3
CH 128K	Organic Chemistry Laboratory	1
CH 301	Principles of Chemistry I	3
CH 302	Principles of Chemistry II	3
CH 204	Introduction to Chemical Practice	2
CH 320M	Organic Chemistry I	3

or CH 328M	Organic Chemistry I	
Mathematics		
M 408C	Differential and Integral Calculus (mathematics; quantitative reasoning flag)	4
M 408D	Sequences, Series, and Multivariable Calculus	4
M 427J	Differential Equations with Linear Algebra (quantitative reasoning flag)	4
[~~or M 427K~~	~~Advanced Calculus for Applications I~~]	
Physics		
PHY 103M	Laboratory for Physics 303K	1
PHY 103N	Laboratory for Physics 303L	1
PHY 303K	Engineering Physics I (part I science and technology; quantitative reasoning flag)	3
PHY 303L	Engineering Physics II (part I science and technology; quantitative reasoning flag)	3
Rhetoric and Writing		
RHE 306	Rhetoric and Writing (English composition)	3
Remaining Core Curriculum Courses		
E 316L	British Literature (humanities; [~~in E 316L, 316M, 316N, and 316P~~] some sections carry a global cultures or cultural diversity flag)	3
or E 316M	American Literature (humanities; some sections carry a global cultures or cultural diversity flag)	
or E 316N	World Literature (humanities; some sections carry a global cultures or cultural diversity flag)	
or E 316P	Masterworks of Literature (humanities; some sections carry a global cultures or cultural diversity flag)	
American and Texas government (some sections carry a cultural diversity flag)		6
American history (some sections carry a cultural diversity flag)		6
Social and behavioral sciences (some sections carry a global cultures and/or cultural diversity flag)		3
Visual and performing arts (some sections carry a global cultures and/or cultural diversity flag)		3
UGS 302	First-Year Signature Course (in UGS 302 all sections carry writing flag[~~; in UGS 303 some sections carry a writing flag~~])	3
or UGS 303	First-Year Signature Course (in UGS 303 some sections carry a writing flag)	
Minimum Required		**133**

{A new Integrated BSBME/MSE program will inserted here if endorsed by the Committee on Undergraduate Degree Program Review (CUDPR)}

Technical Area Options

The technical area option allows the student to build on the biomedical engineering core curriculum by choosing twelve semester hours of technical area coursework. A minimum of six semester hours of the twelve semester hours of technical area coursework must be taken within engineering. Students choose coursework in one of four areas: biomedical imaging and instrumentation[;]; cellular and biomolecular engineering~~,~~; computational biomedical engineering~~,~~; or biomechanics. Within some technical areas, career emphases are available for students to focus coursework toward a particular career track. Students have flexibility to take

technical elective coursework from more than one career emphasis under the same technical area. Each student should choose a technical area by the end of the sophomore year and plan an academic program to meet the area requirements during the next two years.

Preparation for health professions. Students who plan to attend medical, veterinary, or dental school in Texas must complete coursework in addition to that required for the BS in Biomedical Engineering in order to meet professional school admission requirements; those who plan to attend schools outside Texas may need additional coursework. The student is responsible for knowing and meeting these additional requirements, but assistance and information are available [~~from full-time pre-health professions coaches and part-time peer mentors~~] in the Health Professions Office in the College of Natural Sciences, PAI 5.03. Additional information about preparation for health professions is available online at http://cns.utexas.edu/careers/health-professions/.

Preparation for law. There is no sequential arrangement of courses prescribed for a pre-law program. The Association of American Law Schools puts special emphasis on comprehension and expression in words, critical understanding of the human institutions and values with which the law deals, and analytical power in thinking. Courses relevant to these objectives deal with communication of ideas, logic, mathematics, social sciences, history, philosophy, and the physical sciences. Services for pre-law students are provided to students in all colleges by Liberal Arts Career Services (LACS) in FAC 18, and to engineering students by the Engineering Career Assistance Center (ECAC) in ECJ 3.256. Additional information about preparation for law is available online at http://liberalarts.utexas.edu/lacs/students/prelaw-gradschool/prelaw.php.

Plan II Honors Program. Students enrolled in the Plan II Honors Program are encouraged to contact the Biomedical Engineering Academic Advising Office, in addition to the Plan II Office to ensure that requirements for both programs are met. Plan II courses may count toward biomedical engineering program requirements.

Minors and Certificate programs. Biomedical engineering students may enrich their education through minors and certificate programs. For a full list please see Minor and Certificate Programs.

Common examples of certificates completed by Biomedical engineering students are as follows:

Business Minor. Students who wish to learn about fundamental business concepts and practices may take supplemental coursework that leads to the Business Minor, awarded by the Red McCombs School of Business. The program is described in the Minor and Certificate Programs section in the McCombs School.

Business of Healthcare Certificate. The Red McCombs School of Business offers this certificate to prepare students for the unique challenges and opportunities in the field of healthcare. The program is described in the Minor and Certificate Programs section in the McCombs School.

Elements of Computing. Students who wish to learn about computer science may take the coursework that leads to the certificate in the Elements of Computing, awarded by the Department of Computer Science. The program is described in the Minor and Certificate Programs section of the College of Natural Science. [~~More information about the Elements of Computing Program is available at https://www.cs.utexas.edu/undergraduate-program/academics/elements-computing, and from the Department of Computer Science.~~]

Pre-Health Professions Certificate. This certificate provides majors outside of the College of Natural Sciences [~~(CNS)~~] access to the courses required to complete health professions prerequisites. The program is described in the Minor and Certificate Programs section of the College of Natural Science. [~~The certificate description and application are available at https://cns.utexas.edu/pre-health-professions-certificate from the CNS Health Professions Office.~~]

Bridging Disciplines Programs. These interdisciplinary programs offer students the opportunity to develop skills to collaborate across disciplines and cultures. The programs are listed and described in the Minor and Certificate Programs section in the School of Undergraduate Studies.

Technical Area 1, Biomedical Imaging and Instrumentation

This technical area is designed for students interested in the general area of medical imaging science and instrumentation design. Two career emphases are available in this area: biomedical imaging and biomedical instrumentation. Students are required to select twelve semester hours from any of the Technical Area 1 electives; six of the twelve hours must be within engineering.

Career Emphasis A: Biomedical Imaging. The main objective of this emphasis is to prepare students for a career in biomedical imaging. A solid foundation, practical knowledge, and skills are established in optics, imaging modalities, and image and signal processing.
While students are required to select twelve [~~12~~] hours from any of the Technical Area 1 electives, the following are recommended for the biomedical imaging career emphasis:

Biomedical Engineering 347, *Fundamentals of Biomedical Optics*
Biomedical Engineering 350, *Computational Methods for Biomedical Engineers*
Biomedical Engineering 357, *Biomedical Imaging Modalities*
Biomedical Engineering 358, *Medical Decision Making*
Electrical Engineering 347, *Modern Optics*
Electrical Engineering 351M, *Digital Signal Processing*
Electrical Engineering 371R, *Digital Image and Video Processing*
An approved upper-division biomedical engineering, electrical engineering, or physics course

Career Emphasis B: Biomedical Instrumentation. The main objective of this emphasis is to prepare students to design and use biomedical instrumentation for imaging, diagnostic, and therapeutic applications. A solid foundation, practical knowledge, and skills are established in analog and digital network analysis, software and hardware programming, electronic circuits, sensors, data acquisition systems, image and signal processing, and computational analysis of data as it applies to living systems.

While students are required to select twelve [~~12~~] hours from any of the Technical Area 1 course options, the following are recommended for the biomedical instrumentation career emphasis:

Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*
Biomedical Engineering 374K, *Biomedical Instrument Design*
Biomedical Engineering 374L, *Applications of Biomedical Instrumentation Lab*
Electrical Engineering 312, *Software Design and Implementation I*
Electrical Engineering 319K, *Introduction to Embedded Systems*
Electrical Engineering 438, *Fundamentals of Electronic Circuits I Laboratory*
Electrical Engineering 445L, *Embedded Systems Design Laboratory*
Electrical Engineering 445M, *Embedded and Real-Time Systems Laboratory*
Electrical Engineering 445S, *Real-Time Digital Signal Processing Laboratory*
Electrical Engineering 351M, *Digital Signal Processing*

Technical Area 2, Cellular and Biomolecular Engineering

The major objective of this area is to teach students how to integrate knowledge in cell and molecular biology with engineering analysis, so that they can address problems in molecular-based medicine. Two career emphases are available in this area: biomaterials/regenerative medicine and nanotechnology. Students are required to select twelve semester hours from any of the Technical Area 2 electives; six of the twelve hours must be within engineering.

Career Emphasis A: Biomaterials/Regenerative Medicine. The objective of this emphasis is to prepare students for a career in biomaterials and regenerative medicine engineering. This emphasis includes solid foundation in cell and tissue engineering, biomaterials, and pharmacology. While students are required to select twelve [~~12~~] hours from any of the Technical Area 2 course options, the following are recommended for the biomaterials/regenerative medicine career emphasis:

Biology 320, *Cell Biology*
Biology 325, *Genetics*
Biology 326M, *Introductory Medical Microbiology and Immunology*
Biomedical Engineering 339, *Biochemical Engineering*
Biomedical Engineering 359, *Cellular and Molecular Biomechanics*
Biomedical Engineering 366, *Immune Engineering*
Biomedical Engineering 373, *Tissue, Scaffold and Cell Biomechanics Applications*
Biomedical Engineering 375, *Stem Cells in Cell and Tissue Engineering*
Biomedical Engineering 376, *Cell Engineering*
Biomedical Engineering 379, *Tissue Engineering*
An approved topic of Chemical Engineering 379, *Topics in Chemical Engineering*
Chemistry 320N, *Organic Chemistry II* and 220C, *Organic Chemistry Laboratory*; or 328N, *Organic Chemistry II* and 128L, *Organic Chemistry Laboratory*
Pharmacy PharmD 338, *Introduction to Pharmacology*
An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course

Career Emphasis B: Nanotechnology. The objective of this emphasis is to prepare students for a career in nanotechnology. This emphasis includes solid foundation in nanodevices and sensors, biological physics, and nanocomposites. While students are required to select twelve [~~12~~] hours from any of the Technical Area 2 course options, the following are recommended for the nanotechnology career emphasis:

Biomedical Engineering 346, *Computational Biomolecular Engineering*
Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*
Biomedical Engineering 359, *Cellular and Molecular Biomechanics*
[~~Chemical Engineering 322, *Thermodynamics*~~]
Chemical Engineering 339P, *Introduction to Biological Physics*
An approved topic of Chemical Engineering 379, *Topics in Chemical Engineering*
Chemistry 320N, *Organic Chemistry II* and 220C, *Organic Chemistry Laboratory*; or 328N, *Organic Chemistry II* and 128L, *Organic Chemistry Laboratory*
An approved topic of Mechanical Engineering 379M, *Topics in Mechanical Engineering*
An approved upper-division biomedical engineering, chemical engineering or mechanical engineering course

Technical Area 3, Computational Biomedical Engineering

The objective of this area is to provide students with the knowledge and skills that will enable them to design and use computational algorithms to address problems in biomedical research and health care. Examples include (a) designing medical decision aids using statistical and machine learning models, (b) dynamic modeling and computer simulation to study the biomechanics and control of movement, (c) development of thermodynamic models of dynamic processes at the microscopic and macroscopic scales in biological systems, and (d) image processing techniques for quantitative measurement and interpretation of biomedical images.

Students must select twelve [~~12~~] hours from the following; six of the twelve hours must be within engineering:

Biomedical Engineering 345, *Graphics and Visualization Laboratory*
Biomedical Engineering 346, *Computational Biomolecular Engineering*
Biomedical Engineering 347, *Fundamentals of Biomedical Optics*
Biomedical Engineering 348, *Modeling of Biomedical Engineering Systems*
Biomedical Engineering 350, *Computational Methods for Biomedical Engineers*
Biomedical Engineering 357, *Biomedical Imaging Modalities*
Biomedical Engineering 358, *Medical Decision Making*
Electrical Engineering 312, *Software Design and Implementation I*
Electrical Engineering 319K, *Introduction to Embedded Systems*

Electrical Engineering 422C, *Software Design and Implementation II*
Electrical Engineering 360C, *Algorithms*
Electrical Engineering 371R, *Digital Image and Video Processing*
Mathematics 325K, *Discrete Mathematics*
Mathematics 340L, *Matrices and Matrix Calculations*
A computer science course from an approved list

Technical Area 4, Biomechanics

The major objective of this area is to provide students with knowledge of the structure and function of biological systems by means of the methods of mechanics. Students will learn skills to apply engineering principles to understand how living systems function at all scales of organization and to translate this understanding to the design of devices and procedures that will improve diagnostic and therapeutic methods in health care.

Students must select twelve [~~12~~] hours from the following; six of the twelve hours must be within engineering:

Biomedical Engineering 342, *Biomechanics of Human Movement*
Biomedical Engineering 346, *Computational Biomolecular Engineering*
Biomedical Engineering 347, *Fundamentals of Biomedical Optics*
Biomedical Engineering 354, *Molecular Sensors and Nanodevices for Biomedical Engineering Applications*
Biomedical Engineering 359, *Cellular and Molecular Biomechanics*
Biomedical Engineering 362, *Introduction to Nonlinear Dynamics in Biological Systems*
Biomedical Engineering 373, *Tissue, Scaffold and Cell Biomechanics Applications*
Chemical Engineering 339P, *Introduction to Biological Physics*
Kinesiology 326K, *Biomechanical Analysis of Movement*
Mechanical Engineering 314D[~~324~~], *Dynamics*
[~~Mechanical Engineering 326, *Thermodynamics*~~]
Mechanical Engineering 344, *Dynamic Systems and Controls* and 144L, *Dynamic Systems and Controls Laboratory*
Mechanical Engineering 354, *Introduction to Biomechanical Engineering*
Mechanical Engineering 372J, *Robotics and Automation*
An approved upper-division biomedical engineering or mechanical engineering course

SUGGESTED ARRANGEMENT OF COURSES

First Year

First Term	Hours	**Second Term**	Hours
BIO 311C	3	BME 303	3
BME 303L	3	CH 302	3
UGS 302 or 303	3	CH 204	2
BIO 206L	2	M 408D	4
CH 301	3	PHY 303K	3
M 408C	4	PHY 103M	1
		RHE 306	3
	18		19

Second Year

First Term	Hours	**Second Term**	Hours
BME 214L	2	BME 333T	3
CH 320M or 328M	3	BME 313L	3
CH 128K	1	BME 344	3
BME 311	3	BME 335	3
M 427J [~~or 427K~~]	4	BCH 369	3
PHY 303L	3		
PHY 103N	1		
	17		15

Third Year

First Term	Hours	**Second Term**	Hours
BME 245L	2	BME 261L	2
BME 343	3	BME 355	3
BME 352	3	BME 349	3
BME 365R	3	BME 365S	3
E 316L, 316M, 316N, or 316P	3	Technical area elective	3
Technical area elective	3	BME 353	3
	17		17

Fourth Year

First Term	Hours	**Second Term**	Hours
BME 370	3	BME 371	3
GOV 310L	3	GOV 312L or 312P	3
Technical area elective	3	Visual and performing arts	3
American history	3	Technical area elective	3
Social and behavioral sciences	3	American history	3
	15		15

Total credit hours: 133