SPECIAL REPORT

OF THE

ACADEMIC MATTERS COUNCIL

concerning

REVISION OF THE
BIOMEDICAL ENGINEERING MAJOR
(#5402)

Presented at the
782nd Regular Meeting of the Faculty Senate
December 6, 2018

COUNCIL MEMBERSHIP

ACADEMIC MATTERS COUNCIL

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ACADEMIC MATTERS COUNCIL

The Academic Matters Council recommends approval of this proposal.

Briefly describe the Proposal

This proposal seeks to revise the existing B.S. curriculum in Biomedical Engineering. At the start of the students fourth semester they are likely not prepared to determine what track they would like to pursue within the Biomedical Engineering curriculum. Thus, the department believes that all students in the program should be exposed to key foundation courses (Biomechanics, Biomaterials and Bioinstrumentation). The students do not have to declare a track, but have the option of doing so. Additionally, before the students take biomaterials and bioinstrumentation we will require them to have an introduction to material science (MIE 201 instead of CHEM-ENG 226), and an introduction to electrical engineering (ECE 361 in place of a foundation) so that we can further explore these concepts in the BME required courses. The old curriculum included 4 foundation and 4 elective courses in a given track. The new proposed curriculum now requires 3 foundation courses and 5 elective courses to take in any of the three tracks.

Please describe the existing program requirements, listing all required courses and available electives, as well as any additional requirements, and continuation or admissions policies.

Admission to the Major

College of Engineering students are eligible to be admitted to the Biomedical Engineering major if they have cumulative and most recent regular semester GPAs of 2.0 or higher and have completed with grades of C or better: MATH 131; MATH 132; ENGIN 114 (or ENGIN 100, 110, 111, 112, or 113); ECE 122 or CS 121; PHYSICS 151; CHEM 111 or PHYSICS 152; and ENGLWRIT 112. Students not yet admitted to BME major must be granted permission by the department to enroll in BME courses.

Requirements

Students must satisfy the following requirements and the general university graduation requirements.

No course taken on a Pass/Fail basis may be applied to General Education, major or PR-ENGIN requirements.

Biomedical Engineering Courses
ENGIN 114 Introduction to Biomedical Engineering
BME 210 Bioengineering
BME 230 Statics and Dynamics
BME 310 Introduction to Laboratory Techniques
BME 320 Instrumentation
BME 330 Quantitative Physiology
BME 415 Capstone Project
BME 430 Systems Biology
BME 470 Ethics and Regulations

Other Courses

ENGIN 191 Freshman Seminar
CHEM 111 Chemistry I
CHEM 112 Chemistry II
PHYSICS 151 General Physics I
PHYSICS 152 General Physics II
MATH 131 Calc I
MATH 132 Calc II
MATH 233 Multivariate Calculus
MATH 331 Differential Equations
KIN 270 Anatomy and Physiology I
MIE 211 Strength of Materials
ChE 226 Thermodynamics
ENGLWRITE 112 College Writing
ENGIN 351 Writing in Engineering
STAT 515 Statistics I
ECE 122 or CMPSCI 121 Intro to Problem Solving

BME students are also required to earn credit in a set of eight foundation and elective courses approved by the Undergraduate Program Director. These courses include foundation courses in Biomechanics, Biomaterials and Instrumentation and electives chosen from among advanced courses in BME, Biochemistry, Chemical Engineering, Chemistry, Electrical Engineering, Kinesiology, Microbiology and Mechanical Engineering.

Please describe the requirements that you are proposing, listing course requirements, elective options, as well as any additional requirements, and continuation or admissions policies.

Admission to the Major- No change is proposed.

No course taken on a Pass/Fail basis may be applied to General Education, major or PR-ENGIN requirements.

This proposed new Biomedical Engineering curriculum includes 3 required track foundation courses (Biomechanics (BME 275), Biomaterials (BME XXX) and Bioinstrumentation(BME 320)) that were not included in the previous proposed degree program. In the previous program requirements, the students were given more choice in their 3 foundation courses. Additionally, since Biomaterials is a required course, CHEM-ENG 226 has been replaced with MIE 201 (Intro to Material Science) so that students have a foundation in material science before taking Biomaterials. Similarly, since Bioinstrumentation is now a required course, ECE 361 has been added to the required courses.

Biomedical Engineering Courses
ENGING 114 (or 100,110,111,112,113)
BME 210 Bioengineering
BME 230 Statics and Dynamics
BME 275 Biomechanics
BME 320 Bioinstrumentation
BME XXX Biomaterials
BME 310 Introduction to Laboratory Techniques
BME 330 Quantitative Physiology
BME 415 Capstone Project
BME 430 Systems Biology
BME 470 Ethics and Regulations

Other Courses

ENGIN 191 (freshman seminar)
CHEM 111 Chemistry I
CHEM 112 Chemistry II
PHYSICS 151 General Physics I
PHYSICS 152 General Physics II
MATH 131 Calc I
MATH 132 Calc II
MATH 233 Multivariate Calculus
MATH 331 Differential Equations
KIN 270 Anatomy and Physiology I

MIE 211 Strength of Materials
MIE 201 Introduction to Material Science
ENGLWRITE 112 College Writing
ENGIN 351 Writing in Engineering
STAT 515 Statistics I
ECE 122 or CMPSCI 121 Intro to Problem Solving
ECE 361 Electrical engineering for non-majors

Foundation and Elective Courses

BME students are also required to earn credit in at least 5 elective courses approved by the Undergraduate Program Director. These courses include electives chosen from among advanced courses in BME, Biochemistry, Chemical Engineering, Chemistry, Electrical Engineering, Kinesiology, Microbiology and Mechanical Engineering.

Curriculum Approval and Modifications

Students must obtain written approval from the Undergraduate Program Director for elective course selection and for any curriculum modifications.

Please provide the rationale for these revisions.

These revisions are necessary so that all students are exposed to the track foundations of Biomechanics, Biomaterials and Instrumentation, and so that the necessary pre-requisites are in place so that students can excel in these foundation courses.

Academic Requirements Review

See attached.

Resources

If this proposal requires no additional resources, say so and briefly explain why. If this proposal requires additional resources, explain how they will be paid for. For proposals involving instruction, indicate how many new enrollments are expected and whether the courses have room to accommodate them.

No additional resources are necessary as classes that require resources have not changed, nor has the overall total number of courses or credits.

MOTION: 10-19 **That the Faculty Senate approve the Revision of the Biomedical Engineering, Major, as presented in Sen. Doc. No. 19-023.**

Course Descriptions

Course number: ENGIN 114 Number of Credits: 3

Course Name: Introduction to Biomedical Engineering

Course Description:
This course is intended to provide beginning engineering students with a clear overview of the field of biomedical engineering so they can confidently decide if they want to pursue biomedical engineering as a profession. Throughout the semester, students will develop basic skills in problem solving, computation, design, and communication that will help them in all future engineering courses.

Course number: BME 210 Number of Credits: 4

Course Name: Introduction to Bioengineering
Course Description: This course is an introduction to core Biomedical Engineering principles, as well as an overview of critical facets of mammalian cell biology and human physiology important to practicing Biomedical Engineers. The course covers biological topics of cell division, DNA, receptor-ligand binding, matrix protein assembly, tissue engineering, and cell motility, using a quantitative engineering perspective. Within this biological framework, students learn the basic principles of mass and energy balances, as well as a brief introduction to thermodynamics and transport processes.

Course number: BME 230 Number of Credits: 4

Course Name: Statics & Dynamics
Course Description: This course aims to develop an understanding of the principles of statics and dynamics. Specific topics covered in this course include force and moment vectors, resultants, principles of statics and free-body diagrams, applications to simple trusses, frames, and machines, properties of areas, second moments, internal forces in beams, laws of friction, principles of particle dynamics, mechanical systems and rigid-body dynamics, kinematics and dynamics of plane systems, and energy and momentum of two-dimensional bodies and systems.

Course number: BME XXX Number of Credits: 3

Course Name: Biomaterials
Course Description: This course covers the principles of materials science and cell biology underlying the design of medical implants, artificial organs, and matrices for tissue engineering. Methods for biomaterials surface characterization and analysis of protein adsorption on biomaterials. Molecular and cellular interactions with biomaterials are analyzed in terms of unit cell processes, such as matrix synthesis, degradation, and contraction. Mechanisms underlying wound healing and tissue remodeling following implantation in various organs. Tissue and organ regeneration. Design of implants and prostheses based on control of biomaterials-tissue

interactions. Comparative analysis of intact, biodegradable, and bioreplaceable implants by reference to case studies. Criteria for restoration of physiological function for tissues and organs.

Course number: BME 275 Number of Credits: 3

Course Name: Biomechanics
Course Description: This course introduces the fundamental principles of biomechanics as used in the field of biomedical engineering. Students will realize how mechanical engineering fundamentals can be applied to analyses of the tissues and systems in the human body. Specific topics covered in this course include the mechanical behavior of bone and passive soft tissue, the mechanical behavior of neutrally stimulated skeletal muscle, the application of statics and dynamics to analyzing muscle and joint forces, the biomechanics of gait, orthopaedic biomechanics, and sport biomechanics

Course number: BME 310 Number of Credits: 3

Course Name: Introduction to Laboratory Techniques

Course Description: This course provides an introduction to laboratory techniques in biomedical engineering with an emphasis on cellular processes. Laboratory exercises will explore topics, such as cell culture technique, microscopy and molecular probes, quantification of cell proliferation and migration, and assessment of cellular differentiation in the context of the assigned projects. The student will learn proper handling of laboratory chemicals, operate common analytical instruments, describe the theory and applications of various analytical instruments, and practice laboratory safety.

Course number: BME 320 Number of Credits: 3

Course Name: Bioinstrumentation I
Course Description: Students will learn to amplify and digitize biological signals using electrical and optoelectrical components including operational amplifiers, transistors, light emitting diodes, and photodiodes. The class will include an introduction to concepts of linearity and noise.

Course number: BME 330 Number of Credits: 3

Course Name: Quantitative Physiology
Course Description: This course covers a quantitative description of the function and control of organ systems. Mathematical models are derived to describe physical principles and physiologic mechanisms.

Course number: BME 415 Number of Credits: 4

Course Name: Capstone Project
Course Description: The course requires students to work in small teams to solve a significant biomedical engineering problem. Students develop, design, and implement a solution to the engineering problem in conjunction with a faculty advisor. The course reinforces principles of the engineering design process or the scientific method and serves as a capstone for biomedical engineering knowledge obtained in the BME curriculum. The consideration of the ethical and social implications of technology and scientific results and the basic concepts of business are also aspects of the course. Each team of students is expected to present information related to their project in both written and oral formats. It is expected that results be demonstrated at the end of the course.

Course number: BME 430 Number of Credits: 3

Course Name: Systems Biology
Course Description: This course will show students how to use a quantitative systems approach to understand and predict cell signaling pathways and kinetics, as well as handling the large data sets associated with genomics. Students must have prior knowledge of the basics of cell biology, as well as differential equations. Students will use primarily theoretical approaches and software modeling to develop new approaches to the numerical analysis of proteins, cells and organisms.

Course number: BME 470 Number of Credits: 3

Course Name: Ethics and Regulations
Course Description: This course covers fundamental ethical and regulatory issues that emerge in biomedical engineering. The scope of this subject covers engineering ethics as well as ethics in medical and clinical settings. Regulatory topics include current legal frameworks for engineering and medicine.

Course number: BME 296/396/496 Number of Credits: 3

Course Name: Research
Course Description: This course offers a research experience for students at the sophomore (296), junior (396), and senior (496) level. Students are supervised by an instructor, who develops a specific research project plan and oversees its implementation.