Florida Institute of Technology

ADDING A NEW MAJOR OR MINOR TO THE CURRICULUM

Please provide the following information when requesting a new major or minor (program or option) to be added to the curriculum. Only new majors, minors, and options are assigned a new code and print on the diploma. The code will be assigned by the Office of the Registrar and a copy of this form will be sent to the appropriate department.

COLLEGE: College of Engineering
SITE(S): Melbourne

DEPARTMENT: Biomedical Engineering Program
CAMPUS(ES): Melbourne

PROGRAM TO BE ADDED: ☑ Major or ☐ Minor or ☐ Option for __________________________________ (existing degree program)

NOTE: Only Majors, Minors, and Options receive new codes and print on the diploma; use Option for new program name to appear with existing degree name.

☐ Associate of Arts (A.A.) ☐ Master of Arts (M.A.) ☐ Educational Specialist (Ed.S.)
☐ Bachelor of Arts (B.A.) ☐ Master of Business Administration (M.B.A.) ☐ Doctor of Philosophy (Ph.D.)
☑ Bachelor of Science (B.S.) ☐ Master of Education (M.Ed.) ☐ Doctor of Psychology (Psy.D.)
☐ Master of Public Administration (M.P.A.) ☐ Master of Science (M.S.) ☐ Graduate Certificate
☐ Master of Science in Aviation (M.A.)

OTHER ADDITION TO THE CURRICULUM (NOTE: Only Majors, Minors, and Options receive new codes and print on the diploma; use Concentration or Specialization if the new program represents less than a full degree curriculum.)

☐ Concentration or ☐ Specialization for __________________________________ (existing degree program)

PROGRAM TITLE Restricted to 30 characters, including spaces
BS in Biomedical Engineering

TERM TO BE INITIATED: Fall 2012 ADVISER FOR NEW PROGRAM

ROUTING APPROVALS: 1) Department head/program chair and college dean approve and sign form; 2) Provost approves business plan of the program in terms of financial viability and impact on the university mission, and signs form; 3) Undergraduate Curriculum Committee or Graduate Council approves academics and signs form; 4) Provost gives final approval of program, signs form and forwards to Office of the Registrar.

1) Date: 1/19/11
Department Head/Program Chair

Dean of Associate Dean

Provost

3) Date: 1/19/11
Chair, Graduate Council

OR

Chair, Undergraduate Curriculum Committee

4) Date: 1/20/11
Provost

REGISTRAR’S USE ONLY

FSA ATLAS: SOAXREF: SMAPRLE:
STVMAJR: SOACTCURR: Major Code Assigned
SAOXCUR: CIPC Code: Operator Initials/Date:

Florida Institute of Technology - Office of the Registrar
150 West University Boulevard, Melbourne, FL 32901-6975 • (321) 674-6800 • Fax (321) 674-7827
General Information – ext. 8115, Graduation – ext. 8116, Records and Transcripts – ext. 8117, Registration – ext. 8118

RDR-03-050
MEMORANDUM

DATE: January 7, 2010
TO: Undergraduate Curriculum Committee
THROUGH: Dr. Edward Kalajian, Associate Dean College of Engineering
FROM: Dr. Kunal Mitra, Program Chair, Biomedical Engineering Program
RE: BS in Biomedical Engineering

Attached are the documents for proposed new BS in Biomedical Engineering introduced by College of Engineering.

1. Catalog Description of Biomedical Engineering Program showing the Program Plan
2. Course approval sheets with Syllabus and ABET supporting documentation for 8 new courses introduced as part of this new BS curriculum
3. Sample listing of Biology and Chemistry courses for proposed BS program compared to other universities

Brief Background about the Program:
Preparation for this new BS program was initiated by a request from the Provost Office during Summer of 2010. College of Engineering and College of Science worked together to develop this new BS program. Selection of basic science courses was done through consultation with Dr. Julia Grimwade and Dr. Richard Aronson of Biological Sciences Department. A College of Engineering subcommittee was next formed to review the details of the program plan. Detailed program and business plan was next submitted to the Office of Provost around end of October 2010. Business plan included a detailed analysis of projected enrollment starting Fall 2012 and revenue over expenditures. Office of Provost reviewed the financial viability of the proposed program and approval to proceed with the new program was obtained in November 2010. All the new courses will have BME suffix which has been approved in Fall 2010 by the Office of Provost for biomedical engineering related courses at graduate and undergraduate level.
BIOMEDICAL ENGINEERING PROGRAM

Mission Statement

The mission of the Biomedical Engineering Program is to pursue excellence in biomedical engineering education, research, and innovation by imparting knowledge for improving human health. This will be accomplished by offering innovative educational programs that integrate biological sciences and engineering, and apply engineering tools, methods and practices to solve technical issues in biology and medicine. Graduates of our programs are highly-skilled biomedical engineers who understand the ethical, social and economic implications of their work and will be able to fill diverse professional roles in industry, graduate school, and medical professions.

Biomedical Engineering, B.S.

Biomedical engineering is concerned with the application of engineering and science methodologies to the analysis of biological and physiological problems and to the delivery of health care. Biomedical engineers develop devices and procedures that solve medical and health-related problems by combining their knowledge of biology and medicine with engineering principles and practices. The biomedical engineer requires the analytical tools and broad physical knowledge of modern engineering and science, fundamental understanding of the biological or physiological system, and familiarity with recent technological breakthroughs. The biomedical engineer serves as an interface between traditional engineering disciplines and living systems and may work in either direction, applying the patterns of living organisms to engineering design or engineering new approaches to human health. Biomedical engineers work with medical scientists, to develop and evaluate systems and products such as artificial organs, prostheses (artificial devices that replace missing body parts), instrumentation, medical information systems, and health management and care delivery systems using his/her knowledge of engineering to create new equipment or environments for such purposes as maximizing human performance, or providing non-invasive diagnostic tools.

The BS in Biomedical Engineering curriculum provides graduates with a quantitative background in biomechanics, bioelectronics, and biotransport. Such a background is increasingly important because of the heavy utilization of biomedical technology in modern medical practice. For students planning to attend medical school, this curriculum includes courses in the sciences that satisfy the entrance requirements of most medical schools with the selection of Organic Chemistry 2 and Biochemistry as technical electives. Students interested in pre-Med will be co-advised by Chair of Pre-Med Studies.

Program Education Objectives

The educational objectives of the Biomedical Engineering Program will prepare graduates to:
• Pursue technical careers addressing challenges in biomedical engineering, medical profession and related areas within the context of ethical, societal and environmental factors.

• Function effectively on and provide leadership to multidisciplinary teams.

• Engaged in life-long learning via progress toward, or successful completion of advanced degrees, professional development and/or industrial training course(s), and/or engineering certification that expands knowledge and appreciation of global contemporary professional issues and practices.

Degree Requirements

Candidates for a Bachelor of Science in Biomedical Engineering must complete the minimum course requirements as outlined in the following curriculum. For definitions of electives for engineering programs, see the Academic Overview section of this catalog.

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**TOTAL CREDITS REQUIRED..........................133**

** Students enrolled in premed program should take BIO 4010 Biochemistry 1 with prerequisite of CHE 2002 Organic Chemistry 2.**
### Undergraduate Curriculum for Biomedical Engineering

**Major Code:** 7xxx  
**Catalog Year:** 2012-2013

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<td>BME 4292 BIOMEDICAL ENG DESIGN 1</td>
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<td>TECHNICAL ELECTIVE *</td>
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<td>GRAND TOTAL: 133 CREDIT HOURS</td>
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* Refer to the listing available from the Mechanical & Aerospace Engineering, Electrical & Computer, and Chemical Engineering Department.

** Students enrolled in premed program should take BIO 4010 Biochemistry 1 with prerequisite of CHE 2002 Organic Chemistry 2.
<table>
<thead>
<tr>
<th>Florida Tech (Proposed)</th>
<th>University of Miami</th>
<th>Georgia Tech</th>
<th>University of Virginia</th>
<th>University of Connecticut</th>
<th>University of South Carolina</th>
<th>University of Texas at Austin</th>
<th>Duke</th>
<th>University of Wisconsin Madison</th>
<th>Texas A&amp;M</th>
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<tr>
<td><strong>General Chemistry 1 with lab</strong></td>
<td>Principles of Chemistry I with Lab</td>
<td>Chemistry Principles I</td>
<td>Introductory Chemistry for Engineers</td>
<td>General Chemistry I</td>
<td>General Chemistry I</td>
<td>Principles of Chemistry I</td>
<td>Principles of Chemistry I</td>
<td>General Chemistry</td>
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<td><strong>Biological Discovery 1 with lab</strong></td>
<td>General Biology with Lab</td>
<td>Biological Principles</td>
<td>General Biology I or Organic Chemistry</td>
<td>Fundamentals of Biology</td>
<td>Biological Principles I</td>
<td>Introductory Biology I</td>
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<tr>
<td><strong>General Chemistry 2 with lab</strong></td>
<td>Principles of Chemistry II with Lab</td>
<td>General Chemistry II</td>
<td>General Chemistry II</td>
<td>Introduction to Chemical Practice</td>
<td>Principles of Chemistry II</td>
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<td>Physiological Modeling</td>
<td>Biological Principles II</td>
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<td><strong>Mammalian Physiology with lab</strong></td>
<td>Medical Systems Physiology</td>
<td>Systems Physiology</td>
<td>Physiology I</td>
<td>Human Physiology and Anatomy</td>
<td>Anatomy and Physiology I</td>
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<td><strong>Cell Biology</strong></td>
<td>Physiology of Cellular and Molecular Systems</td>
<td>Cell &amp; Molecular Biology</td>
<td>Cell and Molecular Biology</td>
<td>Cell &amp; Molecular Biology</td>
<td>Modeling Cellular &amp; Molecular Systems</td>
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<td><strong>Other courses in Biology or Chemistry</strong></td>
<td>Quantitative Engineering Physiology Lab I and II</td>
<td>Physiology II</td>
<td>Anatomy and Physiology II</td>
<td>Physical Chemistry &amp; Thermodynamics</td>
<td>Fundamentals of Biochemistry</td>
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<td><strong>Organic Chemistry 2 (Elective)</strong></td>
<td>Survey of Biochemistry</td>
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<tr>
<td><strong>Biochemistry 1 (Elective)</strong></td>
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</table>
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT: BME COURSE NO. 1045 CREDIT HOURS 3 TERM TO BE ADDED TO THE FILE Fall 2013
CLASS HOURS 45/semester LECTURE HOURS 30/semester LAB HOURS 15/semester CONTACT HOURS (CEU ONLY)
DEPARTMENT Biomedical Engineering/College of Engineering SCHEDULE TYPE Lecture (A)
(e.g., Computer Science)

☐ COLLEGE OF AERONAUTICS - 23 ☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS - 25
☐ NATHAN M. BISK COLLEGE OF BUSINESS - 24 ☐ COLLEGE OF SCIENCE - 26
☒ COLLEGE OF ENGINEERING - 1 ☐ EXTENDED STUDIES DIVISION / NATHAN M. BISK COLLEGE OF BUSINESS - 90

COMPUTER TITLE Restricted to 25 characters, including spaces Intro to Biomed Engr

CATALOG TITLE Introduction to Biomedical Engineering

CATALOG DESCRIPTION OF COURSE Restricted to 350 characters, including spaces

Introduces and overviews biomedical engineering. Provides some historical perspectives and discusses the fundamental principles that underlie biomedical engineering design, analysis and modeling. Also discusses biomedical applications from electrical, chemical and mechanical engineering perspectives in both descriptive and quantitative terms.

This description has been approved by the catalog office

Catalog Director

In addition, please attach a course syllabus and/or more detailed description.

REQUIREMENTS ☐ Prerequisite Course Number ☐ Corequisite Course Number ☐ and ☐ or

☐ Prerequisite Course Number ☐ Corequisite Course Number ☐ and ☐ or

☐ Prerequisite Course Number ☐ Corequisite Course Number ☐ and ☐ or

ADDENDUM: If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT, Alpha Prefix (e.g., CSE) COURSE NO. (e.g., 1301) TERM TO INACTIVATE

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Chair, Graduate Council Date

Chair, Undergraduate Curriculum Committee Date

REGISTRAR'S USE ONLY

SCACRSE ________ SCADETL ________ SCAPREQ ________ SCABASE ________

SCARRES ________ Operator Init. ________ Date ________

Florida Institute of Technology  Office of the Registrar

150 West University Boulevard, Melbourne, FL 32901-6975  321-674-8114  Fax (321) 674-7827
BME 1045 INTRODUCTION TO BIOMEDICAL ENGINEERING
Fall 2012

2011-12 Catalog Data: 3 Credits. Introduces and overviews biomedical engineering. Provides some historical perspectives and discusses the fundamental principles that underlie biomedical engineering design, analysis, and modeling. Also discusses biomedical applications from electrical, chemical, and mechanical engineering perspectives in both descriptive and quantitative terms.

Required or Elective: Required

Prerequisites by Topic: None.

Corequisite by Topic: None.


Course Learning Outcomes: The student will be able to:
1. Explain and discuss what biomedical engineers do in their professional activities
2. Understand living systems/mechanisms through a systems approach and be able to perform related basic quantitative calculations analytically and numerically using scientific software
3. Understand fundamental principles used by biomedical engineers in different technology areas: biomechanics, biomedical imaging and signal processing, cellular and molecular biotechnology, biomaterials and tissue engineering
4. Apply basic principles of science and engineering to study living functions and to understand the operation of biomedical instruments
5. Function effectively as part of a team of student engineers to complete a multi-week engineering design project
6. Write and present oral engineering project proposals and reports
7. Students will learn about the ethics involved in dealing with patients

Topics Covered and Associated Time:
1. Introduction to the Biomedical Engineering Profession (2 lecture classes)
2. Anatomy and Physiology Review (2 lecture classes)
3. Biomaterials (2 lecture classes)
4. Tissue Engineering (2 lecture classes)
5. Drug Delivery (2 lecture classes)
6. Biomechanics (2 lecture classes)
7. Cardiovascular Mechanics (2 lecture classes)
8. Biomedical Informatics (1 lecture class)
9. Modeling of Biological Systems (2 lecture class)
10. Bioelectric Phenomena (2 lecture classes)
11. Biomedical Instrumentation (2 lecture class)
12. Biomedical Sensors (2 lecture classes)
13. Biomedical Imaging Modalities (2 lecture classes)
14. Biomedical Optics and Lasers (2 lecture classes)
15. Biomedical Ethics (1 lecture class)
16. Introduction to software tools (10 lab classes)
17. Design Project Report & Presentation Preparation (4 lab classes)
18. Final Exam

Class Schedule:       Lecture- Tuesday & Thursday: 11:00 AM – 12:15 PM
                      Lab Sessions- Wednesday: 11 AM – 11:50 AM

**Contribution of Course to Meeting the Requirements of Curriculum:** The introduction to anatomy and physiology, biological systems, and the team design project contribute to the one and one-half years of engineering sciences and design. Moreover, the introduction to biological system modeling and biomedical instrumentation and sensing contribute to the biomedical engineering program criterion requirement that students be able to apply science and engineering to solve the problems at the interface of engineering and biology.

**Relationship of Course to Program Outcomes:** See assessment matrix.

**Grading Policy:**
- Class participation: 20%
- Midterm Exam: 25%
- Midterm Presentation: 10%
- Final Presentation: 20%
- Final Exam: 25%

**Prepared By:** Kunal Mitra, Ph.D., Director, Biomedical Engineering.
**Florida Institute of Technology**

**ADDING A NEW COURSE TO THE CURRICULUM**

This course is available for student registration only after the approval process has been completed.

<table>
<thead>
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<th>SUBJECT</th>
<th>COURSE NO.</th>
<th>CREDIT HOURS</th>
<th>TERM TO BE ADDED TO THE FILE</th>
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<tr>
<th>CLASS HOURS</th>
<th>LECTURE HOURS</th>
<th>LAB HOURS</th>
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<td>45/semester</td>
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<th>DEPARTMENT</th>
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<td>Biomedical Engineering/College of Engineering</td>
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<td>NATHAN M. BISK COLLEGE OF BUSINESS - 24</td>
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<tr>
<td>COLLEGE OF ENGINEERING - 1</td>
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**COMPUTER TITLE:** Restricted to 25 characters, including spaces

**Biomechanics**

**CATALOG TITLE:**

**Biomechanics**

**CATALOG DESCRIPTION OF COURSE:** Restricted to 350 characters, including spaces

Studies basic biomechanics concepts. Includes many aspects of dynamics, introductory kinematics and motion analysis, and mechanics of materials as applied to the study of the human musculoskeletal system.

This description has been approved by the catalog office.

**In addition, please attach a course syllabus and/or more detailed description.**

**GRADES TO BE ISSUED**

- A, B, C, D, F
- CEU
- S, U
- P, F
- Other

**ADDITIONAL RESTRICTION**

(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

**APPROVALS:** Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

**CATALOG DIRECTOR**

These changes/additions have been made for the

University Catalog/Policy Management system and entered into the BANNER term named above.

**REGISTRAR'S USE ONLY**

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- SCAPREQ
- SCBASE
- SCARRES
- Operator Init.

**Florida Institute of Technology • Office of the Registrar**

150 West University Boulevard, Melbourne, FL 32901-6975 • (321) 674-8114 • Fax (321) 674-7827

FOR-078-510
BME 3081 BIOMECHANICS
Fall 2012

2011-12 Catalog Data: 3 Credits. Studies basic biomechanics concepts. Includes many aspects of dynamics, introductory kinematics and motion analysis, and mechanics of materials as applied to the study of human musculoskeletal system. (Pre-requisites: MAE 2081 Statics)

Prerequisites by Topic: Physics, Statics, Mathematics, Basic introductory computer skills.


Course Objectives: Students completing the course should be able to:

1. Apply basic laws of statics and dynamics to formulate, solve, and communicate biomechanics load-analysis problems.
2. Understand basic principles related to mechanics of materials applied to biomechanics, and perform simple calculations of stress, strain and deformations due to uniaxial, bending and combined loading.
3. Understand basic concepts of prosthetic design and related current issues, and perform simple calculations.
4. Understand current challenges in biomechanical engineering.

Topics Covered:

1. Statics review (Shear-Moment Diagram formulation, Method of sections) (2 lectures)
2. Introduction to Musculoskeletal System (bone and tissue material characterization) and Prosthetic Devices (2 lectures)
3. Static and Dynamic Loading, and Motion Analysis in the Musculoskeletal System (introduction to position, velocity and acceleration analysis; force and moment equilibria; conservation of angular momentum) (5 lectures)
4. Basic Uniaxial Loading Analysis (Stress, Strain, Deformation, Statically Indeterminate Uniaxially Loaded Structures) (4 lecture)
5. Bending (Normal and Shearing Stresses, Deformation Calculations, Combined Bending and Axial Loading) (6 lectures)
6. Stress Transformations, Principal Coordinate Systems, Mohr’s Circle, Failure Criteria (4 lectures)
7. Buckling (2 lecture)
8. Deformation and Strain Energy: (2 lecture)
9. Midterm and Final Examinations (3 lectures)

Class Schedule: Lecture- Tuesday & Thursday: 3:30 PM – 4:45 PM
**Contribution of Course to Meeting the Requirements of Curriculum:** This course meets the requirements of one and one-half years of engineering science topics.

**Relationship of Course to Program Outcomes:** See assessment matrix.

**Grading Policy:**
- Homework: 10%
- Midterm Exams: $2 \times 25\% = 50\%$
- Final Exam: 40%

**Prepared By:** Dr. Razvan Rusovici, Aerospace Engineering.
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

Subject: BME (e.g., CSE)
Course No.: 3240 (e.g., 1301)
Credit Hours: 3
Term to be added to the file: Fall 2012 (e.g., Fall 2010)

Class Hours: 45/semester
Lecture Hours: 45/semester
Lab Hours: 
Contact Hours (CEU only): 

Department: Biomedical Engineering/College of Engineering
(Specific Discipline)
(Specific Discipline) (e.g., Computer Science)
Schedule Type: Lecture (A)
(Lecture, Lab or Special Topics/Project)

☐ College of Aeronautics - 23
☐ College of Psychology and Liberal Arts - 25
☐ College of Business - 24
☐ College of Science - 26
☐ College of Engineering - 1
☐ Extended Studies Division / Nathan M. Bisk College of Business - 90

Computer Title: Restricted to 25 characters, including spaces
Comp Meth for Bio Sys

Catalog Title: Computational Methods for Biological Systems

Catalog Description: Restricted to 350 characters, including spaces
Introduces the use of numerical methods for solving problems typically encountered in biological systems and biomedical engineering. Uses MATLAB to implement the numerical methods covered.

This description has been approved by the catalog office.

In addition, please attach a course syllabus and/or more detailed description.

Restrictions: Restricted to 25 characters, including spaces

Prerequisite: MTH 2001
Course Number:

Prerequisite: MTH 2201
Course Number:

Prerequisite: MTH 2201
Course Number:

Grades to be Issued: Restricted to 25 characters, including spaces

A, B, C, D, F
A, B, C, D, F, CEU
CEU
S, U
P, F
Other

Additional Restrictions: Restricted to 25 characters, including spaces

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

Subject: Restricted to 25 characters, including spaces
Alpha Prefix: (e.g., CSE)
Course No.: (e.g., 1301)
Term to Inactivate:

Approvals: Upon completion of appropriate departmental approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Originator: 
Date: 1/8/11
Chair, Graduate Council: 
Date: 

Department Head/Program Chair: 
Date: 1/8/11
Chair, Undergraduate Curriculum Committee: 
Date: 1-19-11

Catalog Director: 
Date: 

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SCAPREQ: 
SCABASE: 
SCARIES: 
Operator Init: 
Date: 

Catalog Director: 
Date: 

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150 West University Boulevard, Melbourne, FL 32901-6975 · (321) 674-8114 · Fax (321) 674-7827

RR-07-510
BME 3240 COMPUTATIONAL METHODS FOR BIOLOGICAL SYSTEMS
Fall 2012

2011-12 Catalog Data: 3 Credits. Introduces the use of numerical methods for solving problems typically encountered in biological systems and biomedical engineering. Uses MATLAB to implement the numerical methods covered. (Pre-requisites: MTH 2001 and MTH 2201)

Required or Elective: Required.

Prerequisites by Topic: Differential Equations / Calculus 3

Corequisite by Topic: None.

Grading Policy:
   - Homework (25%)
   - Exams (50%)
   - Final Exam (25%)

Textbook:

Course Learning Outcomes: The student will be able to:
1. Use Matlab as a tool to solve applicable problems in biological systems & biomedical engineering
2. Use Matlab to model and analyze data from biological systems & biomedical engineering
3. Solve linear and nonlinear systems of algebraic equations with applications in biological systems & biomedical engineering
4. Apply numerical integration techniques to solve applicable problems in biological systems & biomedical engineering
5. Solve initial value problems for single and coupled ordinary differential equations with applications in biological systems & biomedical engineering
6. Solve one dimensional boundary value problems for single and coupled ordinary differential equations with applications in biological systems & biomedical engineering

Topics Covered and Associated Time:
1. Introduction to Matlab Basics (1 hr lecture / lab)
2. Matlab Functions, Plotting and Input / Output (2 hr lecture / lab)
3. Matlab Control Structures & Basic Programming (2 hrs lecture / lab)
4. Finding Roots of Polynomials (1 hr lecture / lab)
5. Matrix Definitions & Solving Systems of Linear Equations (1 hr lecture / lab)
6. Solving Single Algebraic Nonlinear Equations Algebraic (2 hrs lecture / lab)
7. Solving Multiple Algebraic Nonlinear Equations (2 hrs lecture / lab)
8. Taylor Series Expansion / Finite Difference Approximations (1 hr lecture / lab)
9. Interpolation Methods & Regression Analysis (1 hr lecture / lab)
10. Numerical Integration  (2 hrs lecture / lab)
11. Initial Value Problems & Ordinary Differential Equations (2 hr lecture / lab)
12. Solving Coupled First Order Ordinary Differential Equations (2 hr lecture / lab)
13. Solving Higher Order Ordinary Differential Equations (1 hr lecture / lab)
14. Boundary Value Problems & Ordinary Differential Equations (3 hr lecture / lab)
15. Introduction to Partial Differential Equations (3 hr lecture / lab)

Class Schedule: two one hour lectures per week and two one hour computer labs per week.

Contribution of Course to Meeting the Requirements of Curriculum: The introduction to numerical methods with application to biomedical engineering meets the requirements of one and one-half years of engineering science topics.

Relationship of Course to Program Outcomes: See assessment matrix.

Prepared By: Jonathan Whitlow Ph.D., Associate Professor of Chemical Engineering,
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT BME
(e.g., CSE)

COURSE NO. 4241
(e.g., 1301)

CREDIT HOURS 3
TERMS TO BE ADDED TO THE FILE
Fall 2012
(e.g., Fall 2010)

CLASS HOURS 45/semester
LECTURE HOURS 45/semester
LAB HOURS
CONTACT HOURS (CEU ONLY)

DEPARTMENT Biomedical Engineering/College of Engineering
(e.g., Computer Science)

SCHEDULE TYPE Lecture (A)
(e.g., Lecture, Lab or Special Topics/Project)

☐ COLLEGE OF AERONAUTICS - 23
☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS - 25
☐ NATHAN M. BISK COLLEGE OF BUSINESS - 24
☐ COLLEGE OF SCIENCE - 26
☒ COLLEGE OF ENGINEERING - 1
☐ EXTENDED STUDIES DIVISION / NATHAN M. BISK COLLEGE OF BUSINESS - 90

COMPUTER TITLE Restricted to 25 characters, including spaces
Transport in Bio Sys

CATALOG TITLE Transport in Biological Systems

CATALOG DESCRIPTION OF COURSE Restricted to 350 characters, including spaces

Brings together fundamental engineering and life science principles to cover key transport concepts in biomedical engineering. Emphasizes heat, mass and momentum transport to solve problems related to biological systems.

This description has been approved by the catalog office.

In addition, please attach a course syllabus and/or more detailed description.

GRADES TO BE ISSUED
☒ A, B, C, D, F
☐ A, B, C, D, F, CEU
☐ CEU
☐ S, U
☐ P, F
☐ Other

ADDITIONAL RESTRICTIONS

(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT Alpha Prefix (e.g., CSE) COURSE NO. (e.g., 1301)

TERM TO INACTIVATE

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Chair, Graduate Council
Date

Date

Chair, Undergraduate Curriculum Committee

Date

CATALOG DIRECTOR

These changes/additions have been made for the University Catalog/policy management system and entered into the BANNER term named above.

Catalog Director
Date

REGISTRAR'S USE ONLY

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SCARRES Operator Init. Date

Florida Institute of Technology · Office of the Registrar

150 West University Boulevard, Melbourne, FL 32901-6975 · (321) 674-8114 · Fax (321) 674-7827
BME 4241 TRANSPORT IN BIOLOGICAL SYSTEMS
Fall 2012

2011-12 Catalog Data: 3 Credits. Brings together fundamental engineering and life science principles to cover key transport concepts in biomedical engineering. Emphasizes heat, mass, and momentum transport to solve problems related to biological systems. (Prerequisites: OCE 3030)

Required or Elective: Required.

Prerequisites by Topic: Fluid Mechanics.

Corequisite by Topic: None.


Course Learning Outcomes: The student will be able to:
1. Derive and formulate constitutive relationships for fluid flow, heat, and mass transport in biological systems.
2. Recognize analytical solutions to well-posed mathematical formulations related to energy and mass transport in biological systems.
3. Apply equations describing mass transfer across membranes.
4. Develop and apply equations describing solute flow in biological tissues modeled as porous media.
5. Solve practical problems involving energy and mass transport in biological systems.

Topics Covered and Associated Time:
1. General overview of transport phenomena (1 lecture class)
2. Physiological fluid mechanics (1 lecture class)
3. Conservation relations for fluid transport (2 lecture class)
4. Basic concepts in heat transfer, heat transfer mechanisms (1 lecture class)
5. Conduction heat transfer (2 lecture classes)
6. Convection heat transfer (2 lecture classes)
7. Radiation heat transfer (2 lecture classes)
8. Mass transport in biological systems (2 lecture classes)
9. Modes of Mass Transfer (1 lecture class)
10. Diffusion-limited reactions (2 lecture classes)
11. Diffusion convection equations (2 lecture classes)
12. Mass transfer across membranes (2 lecture classes)
13. Transport in porous media (2 lecture classes)
14. Chemical kinetics and reaction (2 lecture class)
15. Mass transport at the cellular level (1 lecture class)
16. Transport of gases between blood and tissues (1 lecture class)
17. Transport in organs and organisms (2 lecture class)
18. Midterm and Final Exams (2 lecture classes)

**Class Schedule:** Lecture - Tuesday & Thursday: 11:00 AM – 12:15 PM

**Contribution of Course to Meeting the Requirements of Curriculum:** The introduction to mass, heat, and momentum transport meet the requirements of one and one-half years of engineering science topics.

**Relationship of Course to Program Outcomes:** See assessment matrix.

**Grading Policy:**
- Homework: 10%
- Midterm Exams: 2 x 25% = 50%
- Final Exam: 40%

**Prepared By:** Kural Mitra, Ph.D., Director, Biomedical Engineering.
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT BME (e.g., CSE) COURSE NO. 4 2 5 1 CREDIT HOURS 3 TERM TO BE ADDED TO THE FILE Fall 2012 (e.g., Fall 2010)

CLASS HOURS 45/semester LECTURE HOURS 45/semester LAB HOURS CONTACT HOURS (CEU ONLY)

DEPARTMENT Biomedical Engineering/College of Engineering (e.g., Computer Sciences) SCHEDULE TYPE Lecture (A) (e.g., Lecture, Lab or Special Topics/Project)

☐ COLLEGE OF AERONAUTICS - 23 ☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS - 25
☐ NATHAN M. BISK COLLEGE OF BUSINESS - 24 ☐ COLLEGE OF SCIENCE - 26
☒ COLLEGE OF ENGINEERING - 1 ☐ EXTENDED STUDIES DIVISION / NATHAN M. BISK COLLEGE OF BUSINESS - 90

COMPUTER TITLE Restricted to 25 characters, including spaces Biomed Measure & Inst

CATALOG TITLE Biomedical Measurements and Instrumentation

CATALOG DESCRIPTION OF COURSE Restricted to 350 characters, including spaces

Introduces engineering aspects of detection, acquisition, processing and display of signals from living systems. Covers biomedical sensors, ions and gases in aqueous solution, force, displacement, blood pressure, blood flow, heart sounds, respiration and temperature. Includes therapeutical and prosthetic devices, and medical imaging instrumentation.

This description has been approved by the catalog office

In addition, please attach a course syllabus and/or more detailed description.

RESTRICTIONS ☒ Prerequisite ECE 3222 Course Number ☐ Corequisite Course Number ☐ and or

☐ Prerequisite Course Number ☐ Corequisite Course Number ☐ and or

☐ Prerequisite Course Number ☐ Corequisite Course Number ☐ and or

GRADUES TO BE ISSUED ☒ A, B, C, D, F ☐ A, B, C, D, F, CEU
☐ CEU ☐ S, U ☐ P, F ☐ Other

ADDITIONAL RESTRICTION

(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT Alpha Prefix (e.g., CSE) COURSE NO. (e.g., 1101) TERM TO INACTIVATE

APPROVAL: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

SIGNATURES

Originator 1/6/11 Date 1/14/11

Chair, Graduate Council Date

Dean of Associate Dean 1/14/11

Chair, Undergraduate Curriculum Committee Date

CATALOG DIRECTOR

These changes/additions have been made for the University Catalog policy management system and entered into the BANNER term named above.

Catalog Director Date

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SCABRES Operator Init. Date

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RGR.073.010
BME 4251 BIOMEDICAL MEASUREMENTS AND INSTRUMENTATION
Fall 2012

2011-12 Catalog Data: 3 Credits. Introduces engineering aspects of detection, acquisition, processing, and display of signals from living systems. Covers biomedical sensors, ions and gases in aqueous solution, force, displacement, blood pressure, blood flow, heart sounds, respiration, and temperature. Includes therapeutic and prosthetic devices and medical imaging instrumentation. (Prerequisites: ECE 3222)

Required or Elective: Required.

Prerequisites by Topic: Signals and Systems.

Corequisite by Topic: None.


Course Learning Outcomes: The student will be able to:
1. Understand the limitations of instrumentation in terms of accuracy, resolution, precision, and reliability.
2. Analyze and design operational amplifier and instrumentation amplifier circuits to amplify biosignals.
3. Analyze and design filter circuits to filter unwanted signals from biosignals.
4. Understand the origin of cardiac and muscle biosignals and how they are acquired using ECG and electromyogram electrodes.
5. Understand electrode circuit models and how they affect signal acquisition.
6. Understand the physical modes of operation of various biosensors (amperometric, enzymatic, optical, resistive, capacitive).
7. Describe and compare methods and instrumentation needed to measure pressure and flow in the body.
8. Determine and characterize the factors that limit medical imaging methods in biological tissue.
9. Describe the requirements and limitations of bioinstrumentation in the clinical environment.

Topics Covered and Associated Time:
1. Lecture topics designing medical instruments (2 lecture classes)
2. Displacement sensors (1 lecture class)
3. Temperature and optical sensors (1 lecture class)
4. Amplifiers and signal processing (1 lecture class)
5. Cell, nerve, and muscle potentials (1 lecture class)
6. Electrocardiogram (1 lecture class)
7. Electrode polarization (1 lecture class)
8. Surface electrodes (1 lecture class)
9. Electrocardiograph (1 lecture class)
10. Power line interference (1 lecture class)
11. Blood pressure sensors (1 lecture class)
12. Heart sound sensors (1 lecture class)
13. Blood flowmeters (1 lecture class)
14. Impedance plethysmography (1 lecture class)
15. Respiratory pressure and flow (1 lecture class)
16. Respiratory gas concentration (1 lecture class)
17. Blood-gas sensors (1 lecture class)
18. Noninvasive blood-gas sensors (1 lecture class)
19. Clinical laboratory measurements (2 lecture classes)
20. Radiography, MRI (1 lecture class)
21. Ultrasonic imaging (1 lecture class)
22. Pacemakers and defibrillators (1 lecture class)
23. Cardiac assist devices (1 lecture class)
24. Electroshock hazards (1 lecture class)
25. Electroshock protection (1 lecture class)
26. Midterm and Final Exams (3 lecture classes)

Class Schedule: Lecture- Tuesday & Thursday: 2:00 PM – 3:15 PM

Contribution of Course to Meeting the Requirements of Curriculum: The introduction to biomedical instrumentation and measurements meet the requirements of one and one-half years of engineering science topics.

Relationship of Course to Program Outcomes: See assessment matrix.

Grading Policy:
   Homework: 10%
   Midterm Exams: 2 x 25% = 50%
   Final Exam: 40%

Prepared By: Kunal Mitra, Ph.D., Director, Biomedical Engineering.
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT BME
COURSE NO. 4191
CREDIT HOURS 1
TERM TO BE ADDED TO THE FILE Spring 2013
CLASS HOURS 15/semester
LECTURE HOURS 15/semester
LAB HOURS CONTACT HOURS (CEU ONLY)

DEPARTMENT Biomedical Engineering/College of Engineering
(e.g., Computer Sciences)
SCHEDULE TYPE Lecture (A)
(e.g., Lecture, Lab or Special Topics/Project)

☐ COLLEGE OF AERONAUTICS - 23
☐ NATHAN M. BISK COLLEGE OF BUSINESS - 24
☒ COLLEGE OF ENGINEERING - 1
☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS - 25
☐ COLLEGE OF SCIENCE - 26
☐ EXTENDED STUDIES DIVISION / NATHAN M. BISK COLLEGE OF BUSINESS - 90

COMPUTER TITLE Restricted to 25 characters, including spaces Design Methods & Practice

CATALOG TITLE Design Methodologies and Practice

CATALOG DESCRIPTION OF COURSE Restricted to 350 characters, including spaces

Focuses on developing an understanding of the ethical issues facing biomechanical engineers. Also develops skills in project planning and engineering economics. Presents relevant design projects and case studies by faculty and local practicing physicians. Requires development of a project proposal for BME 4292.

This description has been approved by the catalog office 14/1/11

In addition, please attach a course syllabus and/or more detailed description.

In addition, please attach a course syllabus and/or more detailed description.

RESTRICIONS
☒ Prerequisite BIO 3210
☐ Corequisite, Course Number
☒ Prerequisite BME 3081
☐ Corequisite, Course Number
☒ Prerequisite COM 2223
☐ Corequisite, Course Number

GRADUATES TO BE ISSUED
☒ A, B, C, D, F
☐ A, B, C, D, F, CEU
☐ CEU
☐ S, U
☐ P, F
☐ Other

ADDITIONAL RESTRICTION
And additional prerequisite: OCE 3030

(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT Alpha Prefix (e.g., CSE) COURSE NO. (e.g., 1301) TERM TO INACTIVATE

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Initiator

Date

Chair, Graduate Council

Date

Department Head/Program Chair

Date

Chair, Associate Dean

Date

CATALOG DIRECTOR

These changes/additions have been made to the University Catalog/policy management system and entered into the BANNER term named above.

Catalog Director

Date

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SCARRES Operator Init. Date
BME 4191: DESIGN METHODOLOGIES AND PRACTICE
Spring 2013

2011-12 Catalog Data: 1 Credit. Focuses on developing an understanding of the ethical issues facing biomedical engineers. Also develops skills in project planning and engineering economics. Presents relevant design projects and case studies by faculty and local practicing physicians. Requires development of a proposal for BME 4292. (Prerequisites: COM 2222, BME 3081, OCE 3030, BIO 3210)

Required or Elective: Required

Prerequisites by Topic: Biomechanics, Fluid Mechanics, and Physiology.

Corequisite by Topic: None.

Textbook (T) and References (R): (R) A. Ertas and J.C. Jones, Engineering Design Process, John Wiley & Sons, 1996; (R) C.E. Harris, M.S. Pritchard and M.J. Rabins, Engineering Ethics, Thomson, 2005.

Course Learning Outcomes: The student will be able to:
1. Appreciate introductory concepts of project management techniques.
2. Students will be able to develop a project plan and determine the economic consequences of engineering decisions.
3. Understand general concepts of professional and ethical responsibility.
4. Write team proposals for their senior year capstone design projects.
5. Develop an understanding of multiple issues associated with a capstone design project.
6. Improve their technical communication skills.
7. Acquire knowledge of contemporary issues associated with a capstone design project.

Topics Covered and Associated Time:
1. Team building (2 classes)
2. Project management fundamentals (2 class)
3. Engineering economic decisions (1 class)
4. Project sensitivity and risk analysis (1 class)
5. Professional ethics (2 class)
6. Best business practices (1 class)
7. Presentation of potential capstone design projects (2 classes)
8. Animal subject research (1 class)
9. Human subject research (1 class)
10. Final capstone design proposals (2 classes)

Class Schedule: Monday, 4:00 – 4:50 P.M.

Contribution of Course to Meeting the Requirements of Curriculum: This course meets major design experience requirement.
Relationship of Course to Program Outcomes: See assessment matrix.

Grading Policy:
   Class participation: 20%
   Midterm Presentation: 40%
   Final Presentation: 40%

Prepared By: Kunal Mitra, Ph.D., Director, Biomedical Engineering
**Florida Institute of Technology**

**ADDING A NEW COURSE TO THE CURRICULUM**

This course is available for student registration only after the approval process has been completed.

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COMPUTER TITLE: Restricted to 25 characters, including spaces

Biomed Engr Design 1

CATALOG TITLE: Restricted to 350 characters, including spaces

Biomedical Engineering Design 1

CATALOG DESCRIPTION OF COURSE: Restricted to 350 characters, including spaces

Covers project definition, design and development of potential biomedical products in the context of the student's major capstone project. Presents best practices for designing a marketable medical device. Includes the design process from the clinical problem definition through prototype and clinical testing to market readiness. (Q)

This description has been approved by the catalog office

Catalog Director

1/4/11

In addition, please attach a course syllabus and/or more detailed description.

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<th>RESTRICTIONS</th>
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GRADES TO BE ISSUED

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□ A, B, C, D, F, CEU

□ CEU

□ S, U

□ P, F

□ Other

ADDITIONAL RESTRICTION

(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT Alpha Prefix (e.g., CSE) COURSE NO. (e.g., 1301) TERM TO INACTIVATE

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

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<tr>
<td>Department Head/Program Chair</td>
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<td>Deans' Associate Dean</td>
<td>1/19/11</td>
<td>Chair, Undergraduate Curriculum Committee</td>
<td>Date</td>
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**COLLEGE DIRECTOR**

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Catalog Director

| Date |

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RGR-078-510
BME 4292 BIOMEDICAL ENGINEERING DESIGN 1
Fall 2013

2011-12 Catalog Data: 3 Credits. Covers project definition, design and development of potential biomedical products in the context of the student's major capstone project. Presents best practices for designing a marketable medical device. Includes the design process from the clinical problem definition through prototype and clinical testing to market readiness. (Q) (Prerequisites: BME 4191)

Prerequisites by Topic: Completed proposal for capstone projects.

Corequisite by Topic: None.


Course Learning Outcomes: The student will be able to:
1. Identify design problems related to biomedical engineering devices.
2. Understand the processes involved in project planning, design and development in a team setting.
3. Develop an understanding of the global and societal impact of their design solutions.
4. Identify user needs and product constraints and to use these to formulate design specifications.
5. Design a prototype biomedical device.
6. Develop professional communication skills.
7. Understand the ethical issues involved in testing the prototype devices.
8. Recognize the need for life-long learning.

Topics Covered and Associated Time:
1. Introduction to biomedical device design (2 class)
2. Tour to biomedical engineering labs and clinical sites (3 classes)
3. Engineering design tools, design analysis, and production definition (2 classes)
4. Project management and documentation (2 classes)
5. Customer requirements and design specifications (3 classes)
6. Concept design and engineering mock-up (4 classes)
7. Design, prototyping and commercialization (2 classes)
8. Cooperative learning (in-class interactive team discussions) (7 classes)
9. Final Presentations outlining problem definition, design analysis and concept (3 classes)

Class Schedule: Monday & Wednesday: 4:00 – 4:50 P.M
**Contribution of Course to Meeting the Requirements of Curriculum:** This course meets major design experience requirement.

**Relationship of Course to Program Outcomes:** See assessment matrix.

**Grading Policy:**
- Class participation: 20%
- Midterm Presentation: 40%
- Final Presentation: 40%

**Prepared By:** Kunal Mitra, Ph.D., Director, Biomedical Engineering
Florida Institute of Technology

ADDING A NEW COURSE TO THE CURRICULUM

This course is available for student registration only after the approval process has been completed.

SUBJECT BME
(e.g., CHE)

COURSE NO. 4293
(e.g., 4301)

CREDIT HOURS 3

TERM TO BE ADDED TO THE FILE Spring 2014
(e.g., Fall 2017)

CLASS HOURS 45/semester

LECTURE HOURS 45/semester

LAB HOURS

CONTACT HOURS (CEU ONLY)

DEPARTMENT Biomedical Engineering/College of Engineering
(e.g., Computer Sciences)

SCHEDULE TYPE Lecture (A)
(e.g., Lecture, Lab or Special Topics/Project)

☐ COLLEGE OF AERONAUTICS – 23
☐ COLLEGE OF PSYCHOLOGY AND LIBERAL ARTS – 25
☐ NATHAN M. BISK COLLEGE OF BUSINESS – 24
☐ COLLEGE OF SCIENCE – 26
☒ COLLEGE OF ENGINEERING – 1
☐ EXTENDED STUDIES DIVISION / NATHAN M. BISK COLLEGE OF BUSINESS – 90

COMPUTER TITLE Restricted to 25 characters, including spaces Biomed Eng Design 2

CATALOG TITLE Biomedical Engineering Design 2

CATALOG DESCRIPTION OF COURSE Restricted to 350 characters, including spaces

Continues BME 4292. Covers project definition, design and development of potential biomedical products in the context of student major capstone project. Presents best practices for marketable medical device design. Includes the design process from the clinical problem definition through prototype and clinical testing to market readiness. (Q)

This description has been approved by the catalog office.

In addition, please attach a course syllabus and/or more detailed description.

GRADES TO BE ISSUED
☒ A, B, C, D, F
☐ A, B, C, D, F, CEU
☐ CEU
☐ S, U
☐ P, F
☐ Other

ADDITIONAL RESTRICTION
(e.g., Major, Class Level, Department Head Approval)

If this course replaces a course currently offered in BANNER, please indicate old course information and the date/term the course may be removed from the system.

SUBJECT Alpha Prefix (e.g., CHE) COURSE NO. (e.g., 4301) TERM TO INACTIVATE

APPROVALS: Upon completion of appropriate department approvals, submit form to Chair, Graduate Council, or Chair, Undergraduate Curriculum Committee for approval below and forward to Catalog Director.

Originator
1/6/11

Date

Chair, Graduate Council
1/14/11

Date

OR

Chair, Undergraduate Curriculum Committee
1/17/11

Date

CATALOG DIRECTOR

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RJR-076-S10
BME 4293: BIOMEDICAL ENGINEERING DESIGN 2
Spring 2014

2011-12 Catalog Data: 3 Credits. Continues BME 4292. Covers project definition, design and development of potential biomedical products in the context of the student's major capstone project. Presents best practices for designing a marketable medical device. Includes the design process from the clinical problem definition through prototype and clinical testing to market readiness. (Q) (Prerequisites: BME 4292)

Prerequisites by Topic: Presentation of the design problem.

Corequisite by Topic: None.


Course Learning Outcomes: The student will be able to:
1. Identify design problems related to the construction of biomedical engineering devices.
2. Understand the processes involved in project planning, design and development in a team setting.
3. Develop an understanding of the global and societal impact of their design solutions.
4. Identify user needs and product constraints and to use these to formulate design specifications.
5. Build a prototype biomedical device.
6. Develop professional communication skills.
7. Understand the ethical issues involved in testing the prototype devices.
8. Recognize the need for life-long learning.

Topics Covered and Associated Time:
1. Initial capstone design project presentations (2 classes)
2. Critical design reviews (4 classes)
3. Cooperative learning (in-class interactive team discussions) (18 classes)
4. Oral and written progress report (2 classes)
5. Final oral and written report presentations (2 classes)

Class Schedule: Monday and Wednesday: 3:00 – 4:50 P.M.

Contribution of Course to Meeting the Requirements of Curriculum: This course meets major design experience requirement.

Relationship of Course to Program Outcomes: See assessment matrix.
Grading Policy:
  Class participation: 20%
  Midterm Presentation: 40%
  Final Presentation: 40%

Prepared By: Kunal Mitra, Ph.D., Director, Biomedical Engineering.