

ATTACHMENT 3D

Academic Policy Series

1622.20A

ADD, CHANGE OR DELETE UNIT, PROGRAM REQUIREMENTS, OR ACADEMIC POLICIES

Complete this form consistent with the instructions in Academic Policy 1622.20. Use the form to add, change, or delete a program or unit or to change program policies. Proposed additions and changes must be consistent with Academic Policies 1100.40 and 1621.10 and any other policies which apply.

SECTION I: Approvals

Department / Program Chair Date Submitted Graduate Council Chair Date
College Dean Date Faculty Senate Chair Date
Honors College Dean Date Provost Date
Core Curriculum Committee Date Board of Trustees Approval/Notification Date
University Course and Programs Committee Date Arkansas Higher Education Coordinating Board Approval/Notification Date

SECTION II: Profile Data - Required Information and Name Change Information

Academic Unit: [X] Major/Field of Study [ ] Minor [ ] Other Unit [ ] Policy
Level: [ ] Undergraduate [X] Graduate [ ] Law Effective Catalog Year

Program changes are effective with the next available catalog. See Academic Policy Series 1622.20

Current Name Master of Science in Biomedical Engineering

College, School, Division ENGR Department Code BENG

Current Code (6 digit Alpha) BMENMS Proposed Code (6 digit Alpha) BMEGMS
Prior approval from the Office of the Registrar is required.

[ ] Interdisciplinary Program CIP Code 14.0301
Prior assignment from Office of Institutional Research is required.

Proposed Name
When a program name is changed, enrollment of current students reflects the new name.

SECTION III: Add a New Program/Unit

[X] For new program proposals, complete Sections II and VII and use as a cover sheet for a full program proposal as described in 'Criteria and Procedures for Preparing Proposals for New Programs in Arkansas.' ADHE
http://www.adhe.edu/divisions/academicaffairs/Pages/academicaffairs.aspx

[X] Program proposal uses courses offered by another academic college, and that college dean's office has been notified. The signature of the dean of that academic college is required here:

SECTION IV: Eliminate an Existing Program/Unit

Code/Name Effective Catalog Year
No new students admitted to program after Term: Year:
Allow students in program to complete under this program until Term: Year:

SECTION V: Proposed Changes to an Existing Program or Program Policies

Insert here a statement of the exact changes to be made: Moving the Master of Science in Biomedical Engineering from the Department of Biological and Agricultural Engineering to the newly proposed Department of Biomedical Engineering.

Check if either of these boxes apply and provide the necessary signature:

- Program change proposal adds courses offered by another academic college, and that college dean's office has been notified. The signature of the dean of that academic college is required here: \_\_\_\_\_
- Program change proposal deletes courses offered by another academic college, and that college dean's office has been notified. The signature of the dean of that academic college is required here: \_\_\_\_\_

Check all the boxes that apply and complete the required sections of the form:

- Change of Name and Code (Complete only sections I, II, V and VII.)
- Change Course Requirements: (Complete all sections of the form except "Proposed Name" in II, section III, and section IV.)
- Change Delivery Site/Method (Complete all sections of the form except "Proposed Name" in II, section III, and section IV.)
- Change Total Hours (Complete all sections of the form except "Proposed Name" in II, section III, and section IV.)
- Change in Program Policies

## **SECTION VI: Justification**

*Justify this change and state its likely effect on any other degree program (including those outside the school or college). Identify any program or program components (other than courses) to be eliminated if this program is implemented. (Program and course change forms must also be submitted for such related changes.)*

Biomedical Engineering is a field at the interface of engineering, medicine and biological sciences. It combines the practical problem solving ability of engineering to diagnostic, monitoring, and therapy needs of medical sciences. Even though engineers have designed medical devices for a long time, Biomedical Engineering has only been established as a discipline within the past two decades.

The evolution of academic disciplines often follows the sequence of first being a multi-disciplinary program evolving into an interdisciplinary program and then becoming a discipline in itself with a variety of sub-disciplines. Biomedical Engineering has followed that path and is now widely recognized as a separate discipline within engineering. In the United States, an undergraduate degree in Biomedical Engineering is offered at 99 universities of which three are in the SEC, but none in Arkansas. The SEC schools offering Biomedical Engineering include the University of Tennessee, University of South Carolina and Vanderbilt.

The Biomedical education and research at the University of Arkansas is currently embedded within the department of Biological and Agricultural Engineering which reports to both the College of Engineering and to the Dale Bumpers College of Agriculture and Food and Life Sciences. Undergraduate students have the opportunity to choose Biomedical Engineering as a concentration within a BS degree in Biological Engineering. This stream produces approximately ten such graduates per year. A MS degree in Biomedical Engineering was initiated in 2004 and was accredited by ABET (the national engineering accreditation board) in 2009. The number of graduates in this program range from two to three per year. Doctoral students can choose Biomedical Engineering as a research area but their degree is recognized within the Biological Engineering PhD concentration.

The numbers of graduates at all degree levels with biomedical concentration at the University of Arkansas have been much lower than the national averages. In the past ten years, enrollments at the national level in Biomedical Engineering programs have increased by more than 200% while the overall engineering enrollment increases during the same period have only been at the level of approximately 20%. Similar impressive increases in students have also occurred at the MS and PhD levels. Significantly larger numbers of female students and faculty are attracted to this discipline because of the exciting career opportunities in the health care field. The time is right for the University of Arkansas to re-examine its position on Biomedical Engineering and develop stand-alone degrees at all levels (BS, MS and PhD). This proposal is for creating a new concentration in Biomedical Engineering within the existing PhD degree in Engineering. There are parallel proposals for creating a new undergraduate major in Biomedical Engineering and moving the existing MS

degree in Biomedical Engineering into the proposed new Department of Biomedical Engineering and thereby create exciting educational opportunities in Biomedical Engineering for Arkansans at all levels.

## **SECTION VII: Catalog Text and Format**

*In the box below, insert the current catalog text which is to be changed, with changes highlighted with the color yellow. Include all proposed changes identified in Section V. Only changes explicitly stated in Section V will be considered for approval by the University Course and Programs Committee, the Graduate Council and the Faculty Senate. If you are proposing a new program, give proposed text with all of the elements listed below. If you are proposing modified text, include these elements as appropriate.*

**Include the following elements, in order, in the catalog text for proposed undergraduate program(s) or program changes:**

- State complete major/program name
- Briefly define or describe the major/program or discipline.
- Identify typical career goals or paths for graduates. (Optional)
- State admission requirements (if any) for entry or entry into upper/advanced level of major/program.
- Identify location in catalog of university, college/school, and department/program requirements which the student must meet in addition to hours in the major, but do not restate these requirements.
- State course requirements in the major and any allied areas, giving number of hours and specific courses; specify electives or elective areas and give numbers of hours and courses in elective pools or categories; identify any other course requirements.
- State any other requirements (required GPA, internship, exit exam, project, thesis, etc.).
- Identify name and requirements for each concentration (if any).
- Specify whether a minor or other program component is allowed or required and provide details.
- State eight-semester plan requirements

**For minors, state requirements in terms of hours, required courses, electives, etc.**

**For graduate program/units, include elements (as needed) parallel to those listed for undergraduate programs above.**

**For Law School program/units, prepare text consistent with current catalog style.**

**For centers, prepare text consistent with current catalog style.**

### **BIOMEDICAL ENGINEERING (BMEG), DEPARTMENT OF**

Ashok Saxena

Interim Head of the Department

BELL 4183

479-575-7455

#### **FACULTY**

Distinguished Professors Rardin, Saxena, Varadan (V.K.), Varadan (V.V.)

Professors Ang, Beitle, Carrier, Deaton, El-Shenawee, Kim, Verma, Wickramasinghe

Associate Professors Roper, Tung, Ye

Assistant Professors Hestekin (C.), Jin, Servoss, Wejinya, Wolchok, Zaharoff

### **Biomedical Engineering (BMEG) (M.S.B.M.E.)**

The Master of Science in Biomedical Engineering is a multidisciplinary degree program designed for students from a multitude of academic areas. Regardless of undergraduate discipline, each candidate for the degree must complete a number of basic undergraduate engineering courses. In general, graduates of engineering programs will have completed most, if not all, of these courses and can expect to be accepted with little or no undergraduate prerequisite requirements. However, the prerequisite requirements for graduates of programs other than engineering can be quite significant.

**Program Objectives:** The objectives of the M.S.B.M.E. program are to prepare graduates for careers in biomedical engineering practice with government agencies, engineering firms, or industries and to provide a foundation for continued study at the post-

master's level.

**Primary Areas of Faculty Research:** Bioimaging and Biosensing; Bioinformatics and Computational Biology; Tissue Engineering and Biomaterials; Bio-MEMS/Nanotechnology.

**Prerequisites to Degree Program:** Admission to M.S.B.M.E. is a three-step process. First, the prospective student must be admitted to graduate standing by the University of Arkansas Graduate School. Second, the student must be accepted into the department's program, which depends on transcripts, recommendations, a statement of purpose, and the following additional requirements:

1. A GPA of 3.00 or higher on the last 60 hours of the baccalaureate degree.
2. A GRE score of 1100 or above (verbal and quantitative).
3. A TOEFL score of at least 550 (paper-based) or 213 (computerbased) or 80 (internet based). This requirement is waived for applicants whose native language is English or who earn a bachelor's or master's degree from a U.S. institution.
4. A member of the faculty who is eligible (graduate status of group II or higher) must agree to serve as major adviser to the prospective student.

**Degree Requirements:** All M.S.B.M.E. degree candidates, regardless of previous degree status, must demonstrate completion of the Basic Engineering Education and Biomedical Engineering Breadth requirements listed below. Candidates who do not possess a degree from an ABET-accredited program or equivalent must also satisfy the basic level ABET accreditation requirements. These include completion of no less than 48 credit hours of approved engineering topics and demonstrating, to the satisfaction of the student's graduate study committee, that he/she possesses those abilities and characteristics required of graduates from ABET accredited engineering programs. This shall include the completion of a course that concentrates on a major design project and that results in the production of a design report or other design product as appropriate. The design project must build on and require engineering knowledge and skills from previous course work and must incorporate engineering standards and realistic constraints. The course selected to satisfy this requirement is subject to the approval of the student's graduate study committee. Exceptions to these degree requirements may be requested by means of a petition outlining the reasons for the exceptions and presenting an alternate plan for completing the program. The petition shall be subject to the approval of the student's graduate study committee and the Program Director and Department Head. Credit for courses taken at another institution is subject to the approval of the Program Director and Department Head. In particular, advanced engineering courses (3000, 4000, and 5000-level at the University of Arkansas) normally will not be accepted for transfer from institutions or degree programs that are not accredited by ABET or equivalent.

#### **I. Basic Engineering Education Requirements**

General Education Recommended Courses	Credit Hours
Humanities/social science Acceptable to undergraduate program	15
English composition ENGL 1013 and 1023	6
Mathematics and Basic Science Recommended Courses	
Calculus & differential equations MATH 2554, MATH 2564, MATH 2574, & MATH 3404	16
University Chemistry II CHEM 1123 & 1121L	4
University Physics (calculus based) PHYS 2054 & PHYS 2050L	4
General Microbiology BIOL 2013 & BIOL 2011L	4
Organic Chemistry I CHEM 3603 and CHEM 3601L	4
Introduction to Biochemistry CHEM 3813	3
Human Anatomy BIOL 2443 & BIOL2441L	4
Human Physiology BIOL 2213 & BIOL 2211L	4
Cell Biology BIOL 2533 & BIOL 2531L	4
Basic Engineering Topics Recommended Courses	
Statics MEEG 2003	3

Mechanics of Materials MEEG 3013	3
Fluid Mechanics 3 CHEG 2133 or MEEG 3503	3
Electric Circuits I ELEG 2104	3
Electronic Instrumentation for Biological Systems BENG 3104	3
Thermodynamics MEEG 2403 or CHEG 2313	3

## II. Biomedical Engineering Breadth Requirements (18 hours)

Required Topics Recommended Courses

Biomedical Engineering Principles BENG 4203	3
Tissue Engineering BENG 5233	3
Introduction to Bioinformatics BENG 5213	3
Bio-MEMS BENG 5253	3
Mathematical Modeling of Physiological Systems BENG 5203	3
Transport Phenomena in Biological Systems BENG 4733	3
Mechanical Design in Biological Systems BENG 3803	3
Biosensors and Bioinstrumentation BENG 4123	3
Electronic Instrumentation for Biological Systems BENG 3103	3
Engineering Properties of Biological Materials BENG 3712	3
Topics	
Biomedical Control Systems	3
Reaction Kinetics	3
Signal/Image Processing	3
Control Systems/Theory	3
Biomedical Engineering Physiology	3
Engineering Statistics/Probability	3
Biomechanics	3

## III. Biomedical Engineering Specialization (M.S.B.M.E. graduate program)

Thesis Option: 30 hours of graduate-level course work including 16 hours of core courses as identified below, plus 8 hours of courses from one of the specialty areas identified below, plus 6 hours of research resulting in a written Master's Thesis.

Non-Thesis Option: 33 hours of graduate-level course work including 16 hours of core courses as identified below, plus 14 hours from one of the specialty areas identified below, plus 3 hours of independent study resulting in a written Master's Report.

### Core Courses:

BENG 5203 Mathematical Modeling of Physiological Systems  
 BENG 5801 Graduate Seminar  
 BENG 5103 Advanced Instrumentation in Biological Engineering  
 BENG 5703 Design and Analysis of Experiments for Eng, Research or  
 BENG 5223 Biomedical Engineering Research Internship  
 6 hours of Advanced Science Courses chosen from the list below

### Advanced Science Courses:

CHEM 5813

CHEM 5843  
CHEM 6873  
CHEM 6883  
BIOL 5263  
BIOL 5334  
BIOL 5343  
BIOL 5423  
BIOL 5513  
KINS 5323  
KINS 5333  
KINS 5513  
KINS 5523  
KINS 5543  
KINS 6323  
KINS 6343

Specialty Areas and Approved Courses: Students are expected to select the required hours of graduate courses from one of the four following specialty areas and listing of approved courses. Other courses will be considered on petition to the student's graduate study committee and the Director and Department Head.

**Bioimaging and Biosensing:**

Recommended Courses

BENG 4123 Biosensors and Bioinstrumentation

Elective Courses (one elective and two advanced science courses may come from the following)

INEG 4533 Application of Machine Vision  
CHEM 4213 Instrumental Analysis  
CHEM 5223 Chemical Instrumentation  
CHEM 5243 Electrochemical Methods of Analysis  
CHEM 5253 Spectrochemical Methods of Analysis  
ANAT 5203 Neurophysiology Recording Techniques (UAMS)  
PHYO 5063 Molecular Biophysics (UAMS)  
PHYO 510V Radiation Biology (UAMS)

**Bioinformatics and Computational Biology:**

Recommended Courses

BENG/CSCE 5213 Introduction to Bioinformatics  
CSCE 5043 Advanced Artificial Intelligence

Elective Courses (one elective and two advanced science courses may come from the following)

BIOL 5263 Cell Physiology  
BIOL 5334 Biochemical Genetics  
CHEM 5813 Biochemistry I  
CHEM 5843 Biochemistry II  
MATH 4153 Mathematical Modeling  
ANAT/MBIM/PATH/PHYO 5114 Gene Expression (UAMS)  
BIOC 5103 Biochemistry and Molecular Biology (UAMS)  
MBIM 5904 Genetics and Pathogenesis (UAMS)  
PATH 5043 Molecular and Biochemical Pathology (UAMS)  
PHYO 5063 Molecular Biophysics (UAMS)

**Tissue Engineering and Biomaterials:**

Recommended Courses

BENG 5233 Tissue Engineering  
BENG 5243 Biomaterials

Elective Courses (one elective and two advanced science courses may come from the following)

BENG 4113 Risk Analysis for Biological Systems  
CHEG 5013 Membrane Separation and System Design  
CHEG 5513 Biochemical Engineering Fundamentals  
MEEG 5303 Physical Metallurgy  
MEEG 5393 Engineering Materials Topics  
CHEM 5813 Biochemistry I  
CHEM 5843 Biochemistry II

BIOL 4713 Basic Immunology  
 BIOL 5343 Advanced Immunology  
 KINS 5323 Biomechanics I  
 KINS 6323 Biomechanics II  
 ANAT 5026 Microscopic Anatomy (UAMS)  
 ANAT/MBIM/PATH/PHYO 5114 Gene Expression (UAMS)  
 PCOL 5033 General Principles of Pharmacology and Toxicology (UAMS)  
 PCOL 5063 Toxicology for Graduate Students (UAMS)  
 PHSC 5033 Pharmaceutics for Graduate Students (UAMS)  
 PHSC 517V Advanced Biopharmaceutics and Pharmacokinetics (UAMS)  
 PHYO 5063 Molecular Biophysics (UAMS)  
 PHYO 510V Radiation Biology (UAMS)

**Bio-MEMS and Nano-Biotechnology:**

Recommended Courses

BENG 5253 Bio-MEMS  
 MEPH 5713 Advanced Nanomaterials Chemistry

Elective Courses (one elective and two advanced science courses may come from the following)

MEEG 591V Nanomanufacturing: Materials and Processes  
 BIOL 5334 Biochemical Genetics  
 CHEM 5813 Biochemistry I  
 CHEM 5843 Biochemistry II  
 CHEM 6873 Molecular Biochemistry  
 PHYO 5063 Molecular Biophysics (UAMS)

At least 18 of the 30+ credit hours presented for the M.S.BME. must be 5000-level or higher, and the cumulative grade-point average on all graduate courses presented for the degree must be at least 3.00. The cumulative grade-point average on the basic engineering education and biomedical engineering breadth courses must be at least 2.70.

Candidates for the degree must pass a comprehensive final examination that will include either a defense of the candidate's thesis or a presentation and discussion of the candidate's Master's Report. The examination is to be prepared and administered by the student's graduate advisory committee.

**SECTION VIII: Action Recorded by Registrar's Office**

PROGRAM INVENTORY/DARS

PGRM \_\_\_\_\_ SUBJ \_\_\_\_\_ CIP \_\_\_\_\_ CRTS \_\_\_\_\_

DGRE \_\_\_\_\_ PGCT \_\_\_\_\_ OFFC&CRTY VALID \_\_\_\_\_

REPORTING CODES

PROG. DEF. \_\_\_\_\_ REQ. DEF. \_\_\_\_\_  
 Initials \_\_\_\_\_ Date \_\_\_\_\_

**Distribution**

Notification to:  
 (1) College (2) Department (3) Admissions (4) Institutional Research (5) Continuing Education (6) Graduate School  
 (7) Treasurer (8) Undergraduate Program Committee

5/12/08