Florida Board of Governors
Request to Offer a New Degree Program
13 June 2008 – University of Florida

University of Florida
University Submitting Proposal

Fall 2012
Proposed Implementation Date

College of Engineering
Name of College or School

Biomedical Engineering
Name of Department(s)

Biomedical Engineering
Academic Specialty or Field

BS-BME - 14.0501
Complete Name of Degree
(Include Proposed CIP Code)

The submission of this proposal constitutes a commitment by the university that, if the proposal is approved, the necessary financial resources and the criteria for establishing new programs have been met prior to the initiation of the program.

Date Approved by the University Board of Trustees	President	Date
Signature of Chair, Board of Trustees	Date	Vice President for Academic Affairs	Date

Provide headcount (HC) and full-time equivalent (FTE) student estimates of majors for Years 1 through 5. HC and FTE estimates should be identical to those in Table 1. Indicate the program costs for the first and the fifth years of implementation as shown in the appropriate columns in Table 2. Calculate an Educational and General (E&G) cost per FTE for Years 1 and 5 (Total E&G divided by FTE).

Implementation Timeframe	Projected Student Enrollment (From Table 1)		Projected Program Costs (From Table 2)		
	HC	FTE	Total E&G Funding	Contract & Grants Funding	E&G Cost per FTE
Year 1	20	16.5	$327,532	$0	$19,850
Year 2	50	41.25			
Year 3	60	49.5			
Year 4	70	57.75			
Year 5	90	74.25	$643,622	$0	$8,668

Note: This outline and the questions pertaining to each section must be reproduced within the body of the proposal to ensure that all sections have been satisfactorily addressed.

INTRODUCTION

I. Program Description and Relationship to System-Level Goals

A. Briefly describe within a few paragraphs the degree program under consideration, including (a) level; (b) emphases, including concentrations, tracks, or specializations; (c) total number of credit hours; and (d) overall purpose, including examples of employment or education opportunities that may be available to program graduates.

a) The proposed degree program is a Bachelors of Science degree in Biomedical Engineering.
b) This degree consists of (i) physics, math, and chemistry courses typical of engineering curricula; (ii) life science courses; (iii) foundational engineering courses; (iv) Biomedical Engineering (BME) core courses; and (v) a specialization track in one of several BME application areas. Track offerings will be: biomechanics, biomaterials, bio-molecular engineering and biomedical imaging
c) Total number of credit hours: 132
d) The purpose is to educate students in the rapidly evolving field of biomedical engineering, preparing students for immediate employment in biomedical engineering fields, as well as for graduate and professional school. Below (II B) are given details of the rapidly growing and exceptional need for graduates (II A) as well as demand by students (II B). Examples of careers: product designer for orthopedic implants; field testing for medical electronic devices; services for hospital medical equipment; image analysis for Magnetic Resonance Imaging scanners; software design for medical data use and storage; analysis of genomic data in support of personalized medicine; creation of biomedical product and service companies; management of biomedical product manufacturing; and sales of multiple biomedical products, engineering or otherwise; management of production facilities. Many students go on to graduate education in biomedical engineering, which is growing equally as rapidly. Significant numbers go on to medical school. A smaller number go to other professional schools, e.g. law school for patent law and to business school.

A. Describe how the proposed program is consistent with the current State University System (SUS) Strategic Planning Goals. Identify which goals the program will directly support and which goals the program will indirectly support. (See the SUS Strategic Plan at http://www.flbog.org/about/strategicplan/)

Our proposed degree program will directly support the SUS Strategic Planning Goals:

- A1: Access to and production of degrees: Bachelors
- B3a: Meeting statewide professional and workforce needs/Economic development: emerging technologies/Natural science and technology
- B4: Economic development: high-wage/high-demand jobs

Our proposed degree program will indirectly support the following SUS Strategic Planning Goals:

- A2: Access to and production of degrees: Master's

A1: Access to degrees.
Our proposed undergraduate BME program will allow a much greater number of students to major in biomedical engineering at a major SUS institution. At present, the state of Florida has limited capacity to train Biomedical Engineers. The largest programs are at Florida International University (approximately 70 students/year) and the University of Miami (approximately 50 students/year). By comparison, Georgia Tech enrolls 300 new students per year (2009). Florida has twice the population of Georgia, but less than half the student capacity for BME. Due to the lack of capacity in the state of Florida, students leave the state to study Biomedical Engineering.

A1: Production of Graduates.
Our proposed degree program will increase the number of engineering students at UF and in the SUS, and should result in increased retention of engineering students. This program will also benefit the other engineering programs at UF. The presence of a BME program, including courses available to students in other engineering majors, will attract students to the other departments with biomedical tracks, including Materials Science and Engineering (Biomaterials), Mechanical Engineering (Biomechanics), Chemical Engineering (Tissue engineering), and Agricultural and Biological Engineering. Thus, the proposed BME program should result in an overall institutional improvement in our undergraduate engineering program.

B3a: Meeting workforce needs in Natural Science and Technology.
As cited below in section II, there is substantial and growing demand for a workforce with the skill sets of biomedical engineers which our graduates will fill.

B4: High wage jobs.
Biomedical Engineering jobs are highly valued and paid with salaries similar to other engineering graduates.

A2: Access and production of Master's degrees.
Many of our students will continue to the master's degree, as is the national trend.

The University of Florida College of Engineering is highly ranked (15th among public universities) and the largest College of Engineering in the State. It also is co-located with and has close ties to major medical research and treatment facilities. These provide a solid basis on which to build a successful and nationally ranked undergraduate Biomedical Engineering degree program.

INSTITUTIONAL AND STATE LEVEL ACCOUNTABILITY

II. Need and Demand

A. Need: Describe national, state, and/or local data that support the need for more people to be prepared in this program at this level. Reference national, state, and/or local plans or reports that support the need for this program and requests for the proposed program

which have emanated from a perceived need by agencies or industries in your service area. Cite any specific need for research and service that the program would fulfill.

Our proposed BS-BME degree program will meet several of the goals of the State of Florida's K-20 strategic plan, which goals (as written in state law) are:

1. Highest student achievement
2. Seamless articulation and maximum access
3. Skilled workforce and economic development
4. Quality, efficient services.

Specifically for goal 3, this proposed program will have substantial impact. One report indicates that the biomedical engineering job market nationwide is expected to grow by 72 percent from 2008 to 2018 (Department of Labor). Another (U.S. Bureau of Labor statistics), indicates "biomedical engineers are expected to have 21% employment growth over the projected decade [2006-2016], much faster than the average for all other occupations." Regardless of which is closer to the truth, there is very clear expectation that job growth in biomedical engineering will by far outpace the growth all engineering fields.

In its 2003 report by Workforce Florida, Inc to the state's High Skills/High Wages council, 4 out of the 6 challenges to develop workforce in this area were related to high quality education in the biomedical area. It is imperative that the State of Florida prepares its students for this expanding area, which will contribute to new regional and state business development.

The job market for biomedical engineers in Florida is very good. The state has a very strong biomedical / biopharmaceutical / biotechnology industry that needs sales, marketing, and technical support people with a broad science and engineering backgrounds. According to the FDA (2007), Florida ranks 2nd in the U.S. for the number of FDA-registered medical device establishments. The bio-computational area, especially coupled with biomolecular engineering is a strong field, as is the field of biomechanics for prosthetics (knees, hips) to serve the aging Florida population.

We underscore that demand for BME undergraduate degree holders is perceived as very great by citing trends in the development of BME programs nationwide. As of Oct 2007, the Accreditation Board for Engineering and Technology (ABET) had accredited 53 B.S. programs in Bioengineering or Biomedical Engineering. This is up from just 24 programs in 2003. There are now over 100 departments of Biomedical Engineering, up from roughly 25 in 1990; most offer BS degrees in Biomedical Engineering.

B. Demand: Describe data that support the assumption that students will enroll in the proposed program. Include descriptions of surveys or other communications with prospective students.

Nationwide, Biomedical Engineering is a popular major. Data collected by the American Society of Engineering Education (ASEE) show that it is the 8th most popular engineering degree with 3,237 BS degrees awarded in 2008 (3 times more than 8 years ago), and a full-time bachelors

enrollment of 17,798. Anecdotally, there are some institutions (e.g. Johns Hopkins) where the majority of engineering students wish to enroll in BME. We have enrollment data for two competing state university programs in large engineering colleges. Georgia Tech enrolled 304 new BME majors in 2009 and University of Illinois Urbana Champaign had 599 applications for 40 slots in its BME program in 2009.

There is strong evidence that the demand for Biomedical Engineering at the University of Florida will be similar to the national trends. A survey of undergraduate advisors in the College of Engineering was conducted. The numbers of current students, broken down by current major with an interest in Biomedical Engineering, are: Biological Engineering (100), Mechanical Engineering (51), Materials Science Engineering (21), Chemical Engineering (40-80), and Nuclear & Radiological Engineering (141). While not all those students would necessarily have chosen BME if it had been available, these numbers indicate very strong demand for the Biomedical Engineering major.

C. If similar programs (either private or public) exist in the state, identify the institution(s) and geographic location(s). Summarize the outcome(s) of any communication with such programs with regard to the potential impact on their enrollment and opportunities for possible collaboration (instruction and research). Provide data that support the need for an additional program.

The State of Florida has limited opportunities for students interested in a BS-BME degree. Only three programs (two public) are available. At public universities there is currently the capacity of 120 students per year. We have discussed our proposed program with each public university and are in a agreement that adding our program will not affect the existing programs.

The following are the BME degree programs in the State of Florida:

1. Florida International University offers a BS-BME degree which was ABET accredited in 2006. The department consists of 10 core faculty members and currently enrolls approximately 70 students per year.

2. Florida Gulf Coast University has 5 faculty and enroll approximately 15 students per year in their ABET accredited BME BS degree program.

3. The University of Miami has a long-standing ABET accredited (1997) BME BS degree program. The program unrolls approximately 50 undergraduate students and consists of 10 faculty.

The following is a BME concentrator program in the State of Florida:

4. Florida State University and FAMU jointly run a BME concentration within a Chemical Engineering BS degree program. They enroll approximately 12 students per year, and have 3 BME oriented faculty

The proposed BME BS program at the University of Florida is aimed at exploiting the unique

opportunities available on the Gainesville campus. These include collocated facilities for the Colleges of Medicine, Nursing, Public Health and Health Professions, Pharmacy, and Veterinary Medicine. Also the BME Department facilities are physically in the center of the medical complex including the Shands at UF Hospital, the North Florida Veterans Administration hospital, and numerous research facilities, including the Emerging Pathogens Institute, the McKnight Brain Institute, and the Cancer and Genetics Institute. This enormous investment in biomedical science and practice provides the potential for abundant and unique experiences in Biomedical Engineering education at all levels, including the BS BME degree level. Further the BME program will leverage the excellent resources, both educational and physical, of the highly ranked (15th among public universities) UF College of Engineering. The proposed program will leverage these strengths and opportunities, directly through senior design and research projects, to be carried out in the biomedical context at UF, and indirectly in research opportunities and specialized elective courses offered by the excellent research faculty.

The proposed program should have little to no impact on the existing programs in the State of Florida. In part, this is because Florida, as the 4th largest state, is underrepresented in BME programs and has excess demand on the part of college students. The North/Central part of the state is not served by a university offering a Biomedical Engineering BS degree program. The size of the program proposed is restricted by available resources and will have only minor impact on the UF campus and even less impact on other universities in the state.

D. Use Table 1 (A for undergraduate and B for graduate) to categorize projected student headcount (HC) and Full Time Equivalents (FTE) according to primary sources. Generally undergraduate FTE will be calculated as 40 credit hours per year and graduate FTE will be calculated as 32 credit hours per year. Describe the rationale underlying enrollment projections. If, initially, students within the institution are expected to change majors to enroll in the proposed program, describe the shifts from disciplines that will likely occur.

A new program requires careful consideration of the headcount numbers. In order to keep the student faculty ratio at reasonable levels a slow start is recommended. We will initially start with 20 students to be admitted at the end of their sophomore year (end of Spring 2012). In subsequent years, we will admit 30, 30, 40, and 40 students. Thereafter, enrollment will match the target number of 70 students per class. With this entering class, all curricular, advising and other problems can be resolved on an individual basis. We intend to hire 7 additional faculty over the next 3-4 years to match the increase in enrollment.

Slots are available for transfer students with an AA degree. Approximately 10 percent of our capacity is reserved for transfer students. Admission standards for transfer students will be identical to other students. Critical tracking for transfer students excludes BME3XXX Energy Balance and PCB3XXX Cell and Systems Physiology. Transfer students can take those courses in the Fall semester after transferring.

E. Indicate what steps will be taken to achieve a diverse student body in this program, and identify any minority groups that will be favorably or unfavorably impacted. <u>The university's Equal Opportunity Officer should read this section and then sign and date in the area below.</u>

Engineering academic programs are striving to appeal more strongly to women and underrepresented minority groups in order to maximize the talent in our discipline. Important also is that our graduates will be our liaison to the world at large, and will educate and lead the next generation.

BME, as compared to the balance of engineering disciplines, is highly attractive to women nationwide and should be similarly attractive at the University of Florida. While engineering programs nationwide matriculate 17.8% women overall, for Biomedical Engineering this is 36.9%, the second highest behind Environmental Engineering with 43.7% (ASEE Engineering Statistics 2009).

The recruitment of underrepresented minorities is more challenging. However, Engineering at Florida has one of the most diverse student populations of all engineering schools in the US, especially including the matriculation of Hispanic students. Hence there is considerable support by the UF to achieve this goal.

To augment the more general efforts at UF, the BME Department will participate in the existing College of Engineering's "Successful Transition through Enhanced Preparation for Undergraduate Programs" (STEPUP) program. There are two components to the STEPUP program: a six-week summer residential program, and a non-residential fall and spring semester program. In addition, participants in both the residential and non-residential programs continue to participate in study halls, tutoring, and personalized academic advising throughout their freshman year. Specifically, Biomedical Engineering will do the following:

1. Have a tour and/or seminar in the department during the summer STEPUP program
2. Faculty brown bag lunches with the students during summer STEPUP program.
3. BME faculty will serve as judges in the design project poster competition for STEPUP at the end of the summer session.
4. Connect a STEPUP student interested in BME with an upper division student (as early as possible) to serve as a mentor.

The intent is to provide students with an excellent opportunity to understand what comprises biomedical engineering. By assumption many underrepresented minorities will have had very little opportunity to be acquainted with any form of engineering, let alone biomedical engineering, before arriving on campus. The program goal is to compensate for limited experience so that these students compete on an equal footing (in addition to the general goal of providing advising to students for their careers).

_____ _____

Equal Opportunity Officer Date

III. Budget

A. Use Table 2 to display projected costs and associated funding sources for Year 1 and Year 5 of program operation. Use Table 3 to show how existing Education & General funds will be shifted to support the new program in Year 1. In narrative form, summarize the contents of both tables, identifying the source of both current and new resources to be devoted to the proposed program. (Data for Year 1 and Year 5 reflect snapshots in time rather than cumulative costs.)

(1) Faculty
At present the BME department has 9.25 FTE faculty who have been successful in establishing a highly productive graduate and research program over the 8 years since the department was started. A complement of graduate/senior courses exists. The largest budget change is reallocation of faculty time towards the creation and staffing of the undergraduate courses and the advising of the undergraduate students. Our budgeting assumes a simple model in which faculty contribute equally to graduate and undergraduate teaching. In order to accommodate the growth of the program, the provost has committed support for up to 7 new faculty who will have a standard obligation towards undergraduate and graduate education and research. The enrollment will be restricted to the number of students who can feasibly be taught with a faculty of this size. We have chosen to estimate this number by multiplying the College of Engineering student faculty ratio by the number of faculty.

(2) Staff
The departmental support staff also will be partially redirected to the support of the undergraduate program. However, in years 2-4, additional staff will be hired to manage the undergraduate admissions, advising and recordkeeping as well as maintenance of teaching laboratory equipment and supplies (1.6 person-years percent time and $102,000 dollars).

(3) Equipment and Continuing Expenses
We are also budgeting $40,000 dollars for laboratory equipment annually and a continuing budget for $20,000 dollars of laboratory expenses. Most of the laboratory equipment is budgeted in years 2-4 (not shown in the tables). Starting in year 5 we anticipate an ongoing need to replace and upgrade laboratory equipment.

B. If other programs will be impacted by a reallocation of resources for the proposed program, identify the program and provide a justification for reallocating resources. Specifically address the potential negative impacts that implementation of the proposed program will have on related undergraduate programs (i.e., shift in faculty effort, reallocation of instructional resources, reduced enrollment rates, greater use of adjunct faculty and teaching assistants). Explain what steps will be taken to mitigate any such impacts. Also, discuss the potential positive impacts that the proposed program might have on related undergraduate programs (i.e., increased undergraduate research opportunities,

improved quality of instruction associated with cutting-edge research, improved labs and library resources).

Students currently enrolled in other engineering programs but studying in a biomedical related area may have chosen Biomedical Engineering if it was available. This could potentially drain students from the other departments. We mitigate this three ways: 1) by not allowing current students to transfer into Biomedical Engineering, and 2) by limiting the enrollment to Biomedical engineering while 3) promoting the biomedical related programs and tracks in the other existing engineering programs. We anticipate that when we implement this, overall enrollment to the College of Engineering will increase, and the enrollment numbers for the other departments will not be impacted. Potentially the programs with biomedical content can benefit by the increase in number and quality of the students the BME UG program will attract. Further, BME elective courses will be available to students in other majors.

C. Describe other potential impacts on related programs or departments (e.g., increased need for general education or common prerequisite courses, or increased need for required or elective courses outside of the proposed major).

This program will result in a slight increase in the enrollment in general education, math, physics, chemistry and biology courses that are part of many other majors. These departments have agreed that the small increase our proposed program will not have a major impact. In the senior year, we offer a 15 credit hour specialization track, which could consist of biomedically related courses in other engineering departments. Those departments are also willing and able to take on the incremental student load.

D. Describe what steps have been taken to obtain information regarding resources (financial and in-kind) available outside the institution (businesses, industrial organizations, governmental entities, etc.). Describe the external resources that appear to be available to support the proposed program.

The department currently has a large endowment from the J Crayton Pruitt Family for the support of the greater Biomedical Engineering effort. These funds are largely tied up in the graduate program by offering student fellowships and academic chairs. Continuing outreach is being made with potential donors and industrial partners. Additional funding can be used to enhance the teaching laboratories in instrumentation, tissue engineering, and senior design project design

IV. Projected Benefit of the Program to the University, Local Community, and State

Use information from Table 1, Table 2, and the supporting narrative for "Need and Demand" to prepare a concise statement that describes the projected benefit to the university, local community, and the state if the program is implemented. The projected benefits can be both quantitative and qualitative in nature, but there needs to be a clear distinction made between the two in the narrative.

The program meets the demands of Florida citizens for education in Biomedical Engineering and the needs of the State for well-trained professionals to work in and lead the State's Biomedical Engineering related industries.

Advantages to the State of Florida
Biomedical engineering is a very highly sought degree by the citizens of Florida (as well as by citizens of other states), yet only two BME UG degrees exist at a public university in Florida. The northern part of the state is underserved. A popular, high quality program exists at the Georgia Institute of Technology, which attracts students from the State of Florida. Biomedical Engineering is an area of growth for the state, and students who trained at a state university generally will seek employment in the state. This will allow economic growth in biomedical engineering related companies without the need to import skilled laborers from other states.

Advantages to the University of Florida
Due to the huge demand of students wanting to be trained in Biomedical Engineering, offering a BME BS degree program will bring more applications of students with an interest in BME. Students in BME will also be able to work on collaborative projects within the Health Sciences Center, allowing enhancements of more clinically oriented research, while allowing the BME students to gain critical clinical experiences. Students from the undergraduate program can feed into the BME MS and PhD programs.

Advantages to the College of Engineering
The College of Engineering benefits from a BS-BME degree by attracting new, highly qualified and motivated students, while providing a new high demand major in a growth area.

Advantages to the local community
Gainesville and the surrounding area have a vibrant biomedical industry, mostly from start-up companies resulting from intellectual property development at the University of Florida. The program will further interaction with this industry and supply skilled employees.

V. Access and Articulation – Bachelor's Degrees Only

A. If the total number of credit hours to earn a degree exceeds 120, provide a justification for an exception to the policy of a 120 maximum and submit a request to the BOG for an exception along with notification of the program's approval. (See criteria in BOG Regulation 6C-8.014)

We request an exception to the 120 maximum credit hour rule based on a) general engineering curricula requirements and b) additional knowledge expected of biomedical engineering students in the workplace and professional schools.

a) general engineering curricula requirements
All engineering curricula at UF have at least 128 credit hours. The curricula are highly constrained by the accreditation requirements from ABET (the Accreditation Board for Engineering and Technology). Virtually all engineering programs in the US are accredited by ABET and have similar course requirements. More philosophically, the curricula are driven by the need to provide students with both a general university education as well as a professional education.

b) additional knowledge expected of BME students
BME students are expected to have most of the foundational math, physics and chemistry common to other engineering curricula, as well as baseline engineering coursework. They are also expected to have a solid understanding of bio-molecular science and physiology. Finally, they need advanced biomedical engineering coursework, including concentration in a focus area. To accommodate these needs as best as possible within a feasible undergraduate degree program, we propose a curriculum of 132 hours.

B. List program prerequisites and provide assurance that they are the same as the approved common prerequisites for other such degree programs within the SUS (see Common Prerequisite Manual http://www.facts.org). The courses in the Common Prerequisite Counseling Manual are intended to be those that are required of both native and transfer students prior to entrance to the major program, not simply lower-level courses that are required prior to graduation. The common prerequisites and substitute courses are mandatory for all institution programs listed, and must be approved by the Articulation Coordinating Committee (ACC). This requirement includes those programs designated as "limited access."

If the proposed prerequisites are not listed in the Manual, provide a rationale for a request for exception to the policy of common prerequisites. NOTE: Typically, all lower-division courses required for admission into the major will be considered prerequisites. The curriculum can require lower-division courses that are not prerequisites for admission into the major, as long as those courses are built into the curriculum for the upper-level 60 credit hours. If there are already common prerequisites for other degree programs with the same proposed CIP, every effort must be made to utilize the previously approved prerequisites instead of recommending an additional "track" of prerequisites for that CIP. Additional tracks may not be approved by the ACC, thereby holding up the full approval of the degree program. Programs will not be entered into the State University System Inventory until any exceptions to the approved common prerequisites are approved by the ACC.

Students who complete the courses listed in the 2010-2011 Common Prerequisite Counseling Manual for Biomedical/Bioengineering, will have completed all the prerequisite and critical tracking courses for BS-BME.

C. If the university intends to seek formal Limited Access status for the proposed program, provide a rationale that includes an analysis of diversity issues with respect to such a designation. Explain how the university will ensure that community college transfer students are not disadvantaged by the Limited Access status. NOTE: The policy and criteria for Limited Access are identified in BOG Regulation 6C-8.013. Submit the Limited Access Program Request form along with this document.

The proposed program is intended to be a limited access program. The arguments in favor of this approach are: (a) very large demand is anticipated; (b) especially in the growth phase, resources will be very limited; (c) the development of quality for a new program depends on having reasonable class sizes.

(a) Anticipated Demand
In section II.B, details on demand nationwide, in the state of Florida and at the University of Florida are given. In summary: we can expect demand to be well-above 100 qualified students per year at the outset, with growth expected.

(b) Limited Resources
At present the BME Department has 9.25 FTE faculty. Commitments from the Provost permit growth to 16 FTE. If the faculty were to be expanded beyond this number, funding would have to be identified for salaries and for startup costs, which are high for an intensely experimental field such as BME. Although excellent new space has been created for the BME Department, it is sufficient only for growth to 16 faculty. A significantly larger undergraduate program than planned would require new or renovated building space for additional classrooms and administration as well as for research for the faculty involved.

Note that the Department already administers a graduate program with 85 students and has a full-fledged research program.

(c) Maintenance of Quality
Creation and maintenance of a high quality program requires that enrollment be appropriately managed. This is especially true for the beginning of the program where every course offered is a new course, with need for great attention to curricular matters both great and small. The staging of the enrollment is based on knowledge and communications from other universities to permit the necessary adaptation without sacrifice of the quality of the experience for the students, as well as for faculty who must balance teaching, research and service. In the long run, enrollment proportionate to faculty size is critical to the maintenance of quality.

(d) Plan of Enrollment
The current student / faculty ratio in the college of engineering is 18, implying that 16*4½=72 students per class in steady state is the appropriate target student population. This will establish the University of Florida as the largest BME program in the State of Florida and make a most substantial contribution to the needs / demands of students for BME education and for the State economy for trained biomedical engineers.

Admission to the program will depend on both academic record as well as strength of interest in biomedical engineering, as judged by readers of personal essays. Students will be admitted only if they are clearly capable of completing the rigorous program and if they show very strong personal commitment to the field. These criteria will apply equally to students transferring from community colleges, and as such these students are not disadvantaged.

(e) Transfer Student Policies
The curriculum is designed so that students may take lower level courses that, by articulation agreement, transfer to the University of Florida and satisfy the entrance and tracking requirements. Thus they are not disadvantaged by lack of availability of coursework. Ten percent of admission slots is reserved for transfer students, which will be adjusted as experience

suggest.

Transfer students will apply to the program along with the on-campus students, with selection criteria being common.

D. If the proposed program is an AS-to-BS capstone, ensure that it adheres to the guidelines approved by the Articulation Coordinating Committee for such programs, as set forth in Rule 6A-10.024 (see Statewide Articulation Manual http://www.facts.org). List the prerequisites, if any, including the specific AS degrees which may transfer into the program.

Our program is not an AS-to-BS capstone.

INSTITUTIONAL READINESS

VI. Related Institutional Mission and Strength

A. Describe how the goals of the proposed program relate to the institutional mission statement as contained in the SUS Strategic Plan and the University Strategic Plan.

The program fits squarely in the university's mission of teaching, research and scholarship and its mission to educate students to make significant contributions in an increasingly global community. As the University of Florida belongs to a tradition of great universities, this highly demanded program will prepare Florida citizens to careers working on socially important problems in the delivery of health care using the latest in biomedical technology and engineering knowledge.

B. Describe how the proposed program specifically relates to existing institutional strengths, such as programs of emphasis, other academic programs, and/or institutes and centers.

The Biomedical Engineering department in educational and research mission ties together great strengths at the University of Florida in engineering and health sciences. It leverages existing academic offerings and laboratories especially in engineering, but also from the sciences and medicine. Students will take advantage of the existence of multiple strengths in health sciences including the colleges of Medicine, Nursing, Veterinary Medicine, Public Health and Health Professions, Health and Human Performance, and Pharmacy. Despite its newness, the UF BME department is the only ranked BME department in the state of Florida and the engineering college is ranked 15th of public universities in the nation and by far the highest ranked in the state.

C. Provide a narrative of the planning process leading up to submission of this proposal. Include a chronology (table) of activities, listing both university personnel directly involved and external individuals who participated in planning. Provide a timetable of events necessary for the implementation of the proposed program.

During the planning process of this proposal we have attempted to involve all the stakeholders of biomedical engineering education at UF. These include advisors and administrators of the

engineering departments and the various science departments on campus.

Planning Process

	Participants	Planning Activity
August 2008	Dr. William Ditto, Dr. Hans van Oostrom, and Dr. Bruce Wheeler	Provost preproposal
December 12, 2008	Dr. Bruce Wheeler and Dr. Hans van Oostrom	The Future of Bioengineering and Biomedical Engineering, San Diego, CA
Every 2 weeks beginning in March 2009	Dr. Bruce Wheeler, Dr. Hans van Oostrom, Dr. David Gilland and Tifiny McDonald	Departmental planning committee
April 15, 2009	Dr. Bernard Mair, Dr. Bruce Wheeler, Dr. Hans van Oostrom, Dr. David Gilland and Tifiny McDonald	Meeting with Associate Provost Bernard Mair
April 23, 2009	Dr. David Julian, Dr. Bruce Wheeler, Dr. Hans van Oostrom, Dr. David Gilland and Tifiny McDonald	Detail meeting with HHMI Science for Life program Director and Associate Chair, Biology Department
Every week beginning in May 2009	Dr. David Julian and Dr. Hans van Oostrom	Biology Department/HHMI Collaboration/design of a new physiology course
May 2009	Dr. David Gilland and Dr. Jeffrey J. Keaffaber	Detail meeting with Chemistry Department
May 13, 2009	Dr. Jed Keesling and Dr. Rick Smith (Math), Dr. Bruce Wheeler, Dr. Hans van Oostrom, Dr. David Julian and Tifiny McDonald	Detail meeting with Mathematics department
May 2009	Dr. David Gilland and Dr. R. Donald Allison	Meeting with Biochemistry & Molecular Biology instructor for BCH 4024
September 28, 2009	Drs. Lindner, Wheeler, van Oostrom, Gilland and Tifiny McDonald	Detail meetings with the college
June 2009	Dr. Bruce Wheeler	Chair presentation
Sept 2009		Communication with other state programs
Sept 28, 2009	Meet with Assoc Dean of students Lindner	Discuss admission, diversity, other student issues
Oct 29, 2009	College Curriculum meeting	Seeking approval of the curriculum
Feb 2010	Meeting with Assoc Provost Bernard Mair	Discussion of current status of proposal
Mar 2010	Meeting with Assoc Provost Bernard Mair	Discussion of admission policy
July 2010	Meeting with Assoc Provost Bernard Mair	Finalization of proposal

Events Leading to Implementation

Date	Implementation Activity
Fall 2010	Approvals by university curriculum committee, UF senate, Board of Governors
Fall 2010/Spring 2011	Teach BME 1008 Intro course
Summer 2012	Decision of limited admission of junior students graduating in 2014

VII. Program Quality Indicators - Reviews and Accreditation

Identify program reviews, accreditation visits, or internal reviews for any university degree programs related to the proposed program, especially any within the same academic unit. List all recommendations and summarize the institution's progress in implementing the recommendations.

All engineering programs at the University of Florida are ABET accredited. The next accreditation visits will be in 2012. Our proposed BME UG program is in line with the ABET requirements, and we will seek accreditation when we qualify in alignment with the college-wide accreditation.

VIII. Curriculum

A. Describe the specific expected student learning outcomes associated with the proposed program. If a bachelor's degree program, include a web link to the Academic Learning Compact or include the document itself as an appendix.

See attached (Appendix A)

B. Describe the admission standards and graduation requirements for the program.

The program is planned as a limited enrollment program. Students will be accepted into it at the end of their second year on the basis of overall academics, performance in science and math classes relevant to the major, and an evaluation of the student's ability and desire to complete a Biomedical Engineering degree, including an essay describing their motivation for studying Biomedical Engineering. The bachelors of science degree in Biomedical Engineering will be conferred upon successful completion of the BME program requirements. A GPA of 2.0 is required for all courses completed in the college, a GPA of 2.0 is required in all work attempted in the department and a cumulative GPA of 2.0 is required in all work attempted at the university.

C. Describe the curricular framework for the proposed program, including number of credit hours and composition of required core courses, restricted electives, unrestricted electives, thesis requirements, and dissertation requirements. Identify the total numbers of semester credit hours for the degree.

See attached (appendix B)

D. Provide a sequenced course of study for all majors, concentrations, or areas of emphasis within the proposed program.

See attached (appendix C)

E. Provide a one- or two-sentence description of each required or elective course.

See attached (appendix D)

F. For degree programs in the science and technology disciplines, discuss how industry-driven competencies were identified and incorporated into the curriculum and identify if any industry advisory council exists to provide input for curriculum development and student assessment.

The BME curriculum is informed by national professional societies (Biomedical Engineering Society, American Society for Engineering Education). These societies have active curricular discussion, revision, and promotion activities that have actively engaged industry groups for feedback. The BME Department has an external advisory board, comprised of industry and academic leaders, that meets annually to review all aspects of the Department. The Advisory Board has reviewed the undergraduate program and finds it appropriate for this stage of the department's growth. At full complement of faculty and students, expectations include development of a richer set of elective tracks, integrated with graduate offerings, and eventual conversion of the core engineering required courses to the inclusion of richer biomedical engineering examples. The Department is in the process of expanding the industrial portion of its advisory board in order to improve feedback, especially in the area where undergraduate and graduate (mostly MS) education overlap.

G. For all programs, list the specialized accreditation agencies and learned societies that would be concerned with the proposed program. Will the university seek accreditation for the program if it is available? If not, why? Provide a brief timeline for seeking accreditation, if appropriate.

Most US undergraduate engineering degree programs, including BME, are accredited by the Accreditation Board for Engineering and Technology (ABET). Currently all UF undergraduate engineering programs are accredited by ABET. ABET has specific requirements for Biomedical Engineering, and those components are included in this proposal. The College of Engineering will seek re-accreditation for all its programs in 2012. Biomedical Engineering will seek accreditation as soon as it satisfies the ABET requirements to seek such accreditation.

H. For doctoral programs, list the accreditation agencies and learned societies that would be concerned with corresponding bachelor's or master's programs associated with the proposed program. Are the programs accredited? If not, why?

N/A

I. Briefly describe the anticipated delivery system for the proposed program (e.g., traditional delivery on main campus; traditional delivery at branch campuses or centers; or nontraditional delivery such as distance or distributed learning, self-paced instruction, or external degree programs). If the proposed delivery system will require specialized services or greater than normal financial support, include projected costs in Table 2. Provide a narrative describing the feasibility of delivering the proposed program through collaboration with other universities, both public and private. Cite specific queries made of other institutions with respect to shared courses, distance/distributed learning technologies, and joint-use facilities for research or internships.

Our program will be delivered as a traditional program with lectures and labs on the main campus. We do not anticipate offering any distance learning options initially. Due to the distance to other BME programs in the state, we do not plan to share courses at this time.

IX. Faculty Participation

A. Use Table 4 to identify existing and anticipated ranked (not visiting or adjunct) faculty who will participate in the proposed program through Year 5. Include (a) faculty code associated with the source of funding for the position; (b) name; (c) highest degree held; (d) academic discipline or specialization; (e) contract status (tenure, tenure-earning, or multi-year annual [MYA]); (f) contract length in months; and (g) percent of annual effort that will be directed toward the proposed program (instruction, advising, supervising internships and practica, and supervising thesis or dissertation hours).

B. Use Table 2 to display the costs and associated funding resources for existing and anticipated ranked faculty (as identified in Table 2). Costs for visiting and adjunct faculty should be included in the category of Other Personnel Services (OPS). Provide a narrative summarizing projected costs and funding sources.

The new lines indicated (8 in total, 1 new hire in Spring 2010, 3 new hires in Fall 2010) have been allocated by the Provost. The College of Engineering and the Division of Sponsored research will be providing the startup costs for these positions.

C. Provide the number of master's theses and/or doctoral dissertations directed, and the number and type of professional publications for each existing faculty member (do not include information for visiting or adjunct faculty).

Faculty Name	MS Theses	PhD Dissertations	Professional Publications
Ding, Mingzhou	1	7	115 peer reviewed journal articles 4 book chapters 85 conference papers
Gilland, David	10	4	49 peer reviewed journal articles 34 conference papers 4 book chapters 2 patents
Jiang, Huabei	7	2	122 peer reviewed journal articles 63 conference papers 4 book chapters
Keselowsky, Benjamin	0	1	16 peer reviewed journal articles 16 conference papers 1 book chapter
McFetridge, Peter	6	1	16 peer reviewed journal articles 4 conference papers 2 book chapters 4 patents
Ogle, William	0	0	15 peer reviewed journal articles 13 conference papers 3 book chapters
Ormerod, Brandi	0	0	22 peer reviewed journal articles 24 conference papers 3 book chapters
Sorg, Brian	3	0	29 peer reviewed journal articles 26 conference papers 1 book chapter
van Oostrom, Hans	9	1	16 peer reviewed journal articles 31 conference papers 2 book chapter 10 patens
Wheeler, Bruce	31	9	54 peer review journal articles 4 book chapters 156 conference papers 7 patents

D. Provide evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service. Such evidence may include trends over time for average course load, FTE productivity, student HC in major or service courses, degrees granted, external funding attracted, as well as qualitative indicators of excellence.

While the BME department is relatively young at 8 years, its faculty have excelled in teaching research and service. The graduate academic program has been ranked 47th nationwide, with the expectation that this ranking will improve rapidly as we mature. The graduate program currently has 84 students with about 2/3rd PhD vs. 1/3rd Masters. All faculty participate teaching in the program. Yearly externally funded research expenditures total $1.6 million from multiple sources including NIH, NSF, DOD, and smaller biomedical research foundations.

X. Non-Faculty Resources

A. Describe library resources currently available to implement and/or sustain the proposed program through Year 5. Provide the total number of volumes and serials available in this

discipline and related fields. List major journals that are available to the university's students. Include a signed statement from the Library Director that this subsection and subsection B have been reviewed and approved for all doctoral level proposals.

The University of Florida Libraries own approximately 150,000 monographs in Biomedical Engineering and related areas of the Life Sciences, Engineering, and Medicine as well as approximately 10,000 journal titles in Biomedical Engineering and related areas in the Life Sciences, Engineering, and Medicine.

In addition, the students at the University of Florida have access to over 4,000,000 volumes housed at the University of Florida Libraries. In 2008, the University spent $5.5 million dollars on electronic serial collections. (Data taken from the 2008 Association of Research Libraries Statistics)

The following is a listing of the top 15 highest impact scientific journals with Biomedical Engineering contents. UF subscribes to all but one (available through the interlibrary loan system).

Journal Title	**Impact Factor**	**UF Subscribes?**	**Online?**
Annual Review of Biomedical Engineering	10.780	Yes, online only	1999-present
Biomaterials	6.646	Yes, print at HSCL thru 2004	1995-present
IEEE transactions on medical imaging	4.004	Yes, print at HSCL thru 2006	1982-present
Medical Image Analysis	3.602	Yes, online only	1996-present
Biomechanics and modeling in mechanobiology	3.129	Yes, online only	2002-present
IEEE transactions on neural systems and rehabilitation engineering	2.934	Yes, MSL print thru 2005	2001-present
Biomedical microdevices	2.924	Yes, online only	1998-present
Regenerative Medicine	2.786	No	
Journal of biomechanics	2.784	Yes, HSCL print thru 2004	1995-present
Physics in medicine & biology	2.784	Yes, HSCL thru present, MSL 2006 only in print	1956-present
Clinical oral implants research	2.756	Yes, print at HSCL thru 2006	1997-present
Journal of neural engineering	2.737	Yes, online only	2004-present
Journal of biomedical materials research. Part A	2.706	Yes, online only	2003-present
Annals of biomedical engineering	2.605	Yes, print at MSL thru 2004	1997-present
IEEE transactions on biomedical engineering	2.496	Yes, print at HSCL thru present, MSL thru 2006	1964-present

We have discussed the issues with librarians, concluding that the undergraduate program needs

do not substantially impact the Library, in significant part because the Library already meets the research needs associated with our graduate and research programs. A letter from Dr. Judith Russell, Dean of the Library, is attached.

B. Describe additional library resources that are needed to implement and/or sustain the program through Year 5. Include projected costs of additional library resources in Table 3.

No additional library resources are anticipated (see attached letter).

_____ _____

Library Director Date

C. Describe classroom, teaching laboratory, research laboratory, office, and other types of space that are necessary and currently available to implement the proposed program through Year 5.

Existing classroom space will be utilized. The total number of classroom hours that the program will occupy will be 31 each with almost all classes having fewer than 40 students. One beginning laboratory will be taught in the teaching laboratory space in the Biomedical Sciences Building. The instrumentation laboratory will be taught in space shared with Civil Engineering. The senior design laboratory space will be designated by the Dean of Engineering.

D. Describe additional classroom, teaching laboratory, research laboratory, office, and other space needed to implement and/or maintain the proposed program through Year 5. Include any projected Instruction and Research (I&R) costs of additional space in Table 2. Do not include costs for new construction because that information should be provided in response to X (J) below.

As noted the Dean of Engineering is securing teaching space for the senior design laboratory. In the first 5 years, this will satisfy all teaching needs. Future expansion of the program however would require additional resources.

E. Describe specialized equipment that is currently available to implement the proposed program through Year 5. Focus primarily on instructional and research requirements.

Equipment for the cell and tissue engineering laboratory is available in the Howard Hughes Medical Institute teaching laboratory in the Biomedical Sciences Building. A base of electronic instrumentation for the instrumentation course is available on a shared basis in the Civil Engineering department laboratory.

F. Describe additional specialized equipment that will be needed to implement and/or sustain the proposed program through Year 5. Include projected costs of additional equipment in Table 2.

For the cell and tissue laboratory, additional bio-safety cabinets and incubators and microscopes will be needed. In the instrumentation laboratory, electronic components will be needed to

augment the existing equipment. The senior design laboratory will need outfitting with mixture of electronic, mechanical, chemical, and biological apparatus.

G. Describe any additional special categories of resources needed to implement the program through Year 5 (access to proprietary research facilities, specialized services, extended travel, etc.). Include projected costs of special resources in Table 2.

N/A

H. Describe fellowships, scholarships, and graduate assistantships to be allocated to the proposed program through Year 5. Include the projected costs in Table 2.

N/A

I. Describe currently available sites for internship and practicum experiences, if appropriate to the program. Describe plans to seek additional sites in Years 1 through 5.

N/A

J. If a new capital expenditure for instructional or research space is required, indicate where this item appears on the university's fixed capital outlay priority list. Table 2 includes only Instruction and Research (I&R) costs. If non-I&R costs, such as indirect costs affecting libraries and student services, are expected to increase as a result of the program, describe and estimate those expenses in narrative form below. It is expected that high enrollment programs in particular would necessitate increased costs in non-I&R activities.

N/A

Board of Governors, State University System of Florida
Limited Access Program Request
Reference: BOG Regulation 6.001, Admissions

University:	University of Florida	**Degree(s) offered:**	Biomedical Engineering
Program:	Biomedical Engineering	**Six digit CIP code:**	14.0501

1. Will the entire program be limited access or only a specific track?
The whole program will be limited access

2. If only a track is limited access, please specify the name of the track
_____

3. How many students will the program plan to accommodate?
Fall_20____ Spring_____ Academic Year Total __20__
Note: this is a new program ramping up, the ramp-up of admissions are below:

Semester	Incoming Students
Fall 2012	20
Fall 2013	30
Fall 2014	30
Fall 2015	40
Fall 2016	50
Fall 2017	70

The steady state limit of the program will be 70 new students per year.
The current student / faculty ratio in the college of engineering is 18, implying that 16*4½=72 students per class in steady state is the appropriate target student population. This will establish the University of Florida as the largest BME program in the State of Florida and make a most substantial contribution to the needs / demands of students for BME education and for the State economy for trained biomedical engineers.

4. When do you propose to initiate limited access?
Fall 2012

5. What is the justification for limiting access?

Limited access is requested because (a) very large demand is anticipated; (b) especially in the growth phase, resources will be very limited; (c) the development of quality for a new program depends on having reasonable class sizes.

(a) Anticipated Demand
In section II.B of the full proposal, details on demand nationwide, in the state of Florida and at the University of Florida are given. In summary: we can expect demand to be well-above 100 qualified students per year at the outset, with growth expected.

(b) Limited Resources
At present the BME Department has 9.25 FTE faculty. Commitments from the Provost permit growth to 16 FTE. If the faculty were to be expanded beyond this number, funding would have to be identified for salaries and for startup costs, which are high for an intensely experimental field such as BME. Although excellent new space has been created for the BME Department, it is sufficient only for growth to 16 faculty. A significantly larger

undergraduate program than planned would require new or renovated building space for additional classrooms and administration as well as for research for the faculty involved.

Note that the Department already administers a graduate program with 85 students and has a full-fledged research program.

(c) Maintenance of Quality
Creation and maintenance of a high quality program requires that enrollment be appropriately managed. This is especially true for the beginning of the program where every course offered is a new course, with need for great attention to curricular matters both great and small. The staging of the enrollment is based on knowledge and communications from other universities to permit the necessary adaptation without sacrifice of the quality of the experience for the students, as well as for faculty who must balance teaching, research and service. In the long run, enrollment proportionate to faculty size is critical to the maintenance of quality.

6. By what means will access be limited? Please provide a description of the program's admissions requirements and procedures, and indicate how these requirements and procedures ensure equal access for Florida community college Associate of Arts degree graduates in the competition for available space in the program.

Admission to the program will depend on both academic record as well as strength of interest in biomedical engineering, as judged by readers of personal essays. Students can apply after their sophomore year. As a minimum, students are required to obtain an average GPA of 3.0 in the junior level tracking courses. For UF students, this includes PCB3XXX Cell and Systems Physiology, and BME3XXX Energy Balance. For transfer students these courses are not considered and they can be taken in the Fall semester after transferring. Limited admission is evaluated based academic performance (tracking GPA, overall GPA), and a personal statement. Students will be admitted only if they are clearly capable of completing the rigorous program and if they show very strong personal commitment to the field. These criteria will apply equally to students transferring from community colleges, and as such these students are not disadvantaged.

The curriculum is designed so that students may take lower level courses that, by articulation agreement, transfer to the University of Florida and satisfy the entrance and tracking requirements. Thus they are not disadvantaged by lack of availability of coursework.

Transfer students will apply to the program along with the on-campus students, with selection criteria being common.

7. Present the current race and gender profiles of the students in the program. Discuss the impact of the proposed action on the race and gender profiles. Cite sources used for discussion. What strategies, should they be necessary, will be used to promote diversity in the program?

Engineering academic programs are striving to appeal more strongly to women and underrepresented minority groups in order to maximize the talent in our discipline. Important also is that our graduates will be our liaison to the world at large, and will educate and lead the next generation.

BME, as compared to the balance of engineering disciplines, is highly attractive to women nationwide and should be similarly attractive at the University of Florida. While engineering programs nationwide matriculate 17.8% women overall, for Biomedical Engineering this is 36.9%, the second highest behind Environmental Engineering with 43.7% (ASEE Engineering Statistics 2009).

The recruitment of underrepresented minorities is more challenging. However, Engineering at Florida has one of the most diverse student populations of all engineering schools in the US, especially including the matriculation of Hispanic students. Hence there is considerable support by the UF to achieve this goal.

To augment the more general efforts at UF, the BME Department will participate in the existing College of Engineering's "Successful Transition through Enhanced Preparation for Undergraduate Programs" (STEPUP) program. There are two components to the STEPUP program: a six-week summer residential program, and a non-residential fall and spring semester program. In addition, participants in both the residential and non-residential programs continue to participate in study halls, tutoring, and personalized academic advising throughout their freshman year. Specifically, Biomedical Engineering will do the following:

1. Have a tour and/or seminar in the department during the summer STEPUP program
2. Faculty brown bag lunches with the students during summer STEPUP program.
3. BME faculty will serve as judges in the design project poster competition for STEPUP at the end of the summer session.
4. Connect a STEPUP student interested in BME with an upper division student (as early as possible) to serve as a mentor.

The intent is to provide students with an excellent opportunity to understand what comprises biomedical engineering. By assumption many underrepresented minorities will have had very little opportunity to be acquainted with any form of engineering, let alone biomedical engineering, before arriving on campus. The program goal is to compensate for limited experience so that these students compete on an equal footing (in addition to the general goal of providing advising to students for their careers).

8. Are the graduates of the program in high demand? If so, and if the program is to be limited due to lack of adequate resources, provide a justification for limiting access to the program rather than reallocating resources from programs with low market demand.

Graduates of programs in the broad area of Biomedical Engineering are in high demand nationwide, with growth expected to exceed significantly the growth in most employment fields and other fields of engineering. Demand for the specific major of Biomedical Engineering is exceptionally high nationally. It is important to note, however, that some of the demand, for both intellectual background and future professional positions, can and is being met by traditional majors, especially those that include biomedical engineering or biology related minors as a complement to their degree program. Hence, in aggregate, the College of Engineering provides access significantly greater than can be accommodated within the BME degree program at maximum capacity. Examples of existing programs include the Biomechanics Minor in Mechanical Engineering, the Biomolecular Minor in the Chemical Engineering, and the Biomaterials track in Material Science and Engineering. The BME curriculum is quite distinctive with its rigor and degree of scientific integration. It is

important to match students to the best of the various alternatives, and restriction on enrollment is an important component. Reallocation of resources is already quite significant (e.g. 8 added faculty lines). Further reallocation to handle all who could possibly want BME is not warranted. Restriction of the program size is thus justified for reasons of both resources and appropriate guidance of students into their best career paths.

Request Initiated by:	
EEO Officer's Signature:	
Provost's Signature:	

Send the completed form to:

Dr. Dorothy J. Minear
Sr. Associate Vice Chancellor, Academic and Student Affairs
Board of Governors
State University System of Florida
325 West Gaines Street, Suite 1614
Tallahassee, Florida 32399-1950

Appendix A: Academic Learning Compact

Biomedical Engineering

Description of the major

Biomedical Engineering blends traditional engineering techniques with biological sciences and medicine to improve the quality of human health and life. The discipline focuses both on understanding complex living systems - via experimental and analytical techniques - and on development of devices, methods and algorithms that advance medical and biological knowledge while improving the effectiveness and delivery of clinical medicine.

Before Graduating You Must

- Pass an assessment by two or more faculty and/or industry practitioners of performance on a major design experience.
- Pass assessment in two courses of individual assignments targeted to each learning outcome. Assessment will be provided by the instructor of the course according to department standards.
- Complete an exit interview in your final semester.
- Satisfy the Florida statutes for the College-Level Academic Skills Requirement.
- Complete requirements for the baccalaureate degree, as determined by faculty.

Skills You Will Acquire in the Major (SLOs)

1. Apply knowledge of mathematics, science and engineering principles to biomedical engineering problems.
2. Design and conduct biomedical engineering experiments, analyzing and interpreting the data.
3. To be able to design and build biomedical devices within the constraints of safety and efficacy requirements of application to living organisms.
4. Communicate technical data and design information effectively in writing and in speech to other biomedical engineers.

Courses	Contents		Critical thinking	Communication
	SLO1	SLO2	SLO3	SLO4
BME4XXX Quant. Phys	X			
BME4XXX Biom Instr	X			
BME4XXXL Biom Instr Lab		X	X	X
BME 4XXX Molec BME	X			
BME 4XXX Senior Design 1		X	X	X
BME 4XXX Senior Design 2		X	X	X

BME Undergraduate Curriculum

Appendix B

Requirements by Topic

~ denotes critical tracking courses

			Instructing Dept
MATH			
MAC 2311~	Calculus 1	4	Math
MAC 2312~	Calculus 2	4	Math
MAC 2313~	Calculus 3	4	Math
MAP 2302~	Diff. Eq.	3	Math
		15	
PHYSICS			
PHY 2048/L~	Physics w/ Calc 1	4	Physics
PHY 2049/L~	Physics w/ Calc 2	4	Physics
		8	
CHEMISTRY			
CHM 2045/L~*	Gen. Chem 1	4	Chemistry
CHM 2046/L~*	Gen. Chem 2	4	Chemistry
CHM 3217**	Organic Chem 1	4	Chemistry
BCH 4024	Biochemistry	4	Chemistry
		16	
BIOLOGY			
BSC 2010/L~	Biology 1	4	Biology
PCB 3XXX	Cell & Systems Physiology	4	Biology
		8	
STATISTICS			
STA 3032	Engineering Statistics	3	Statistics
GEN ED (18 credits total)			
	Tech. Writing (3)		CLAS
	Diversity (3)		CLAS
	Humanities (9)		CLAS
	International (3)		CLAS
	Social Science (9)		CLAS
		18	
ENGINEERING CORE			
CGS 2421/L (Comp. Prog. For Engineers)		3	ISE
EML 3007*** (Thermodyn. and heat transfe		3	MAE
EGM 2511 (Engineering Mechanics-Statics)		3	MAE
EMA 3010 (Materials)		3	MSE
BME 3XXX (Energy Balances)		3	BME
EEL 3111C (Circuits 1)		4	ECE
		19	

*The sequence CHM2045/L CHM2046/L can be replaced by CHM2095/L CHM2096/L

**CHM2210+CHM2211 can be substituted for CHM3217

***EMA 4314 (Energy and Kinetics) may be substituted for EML 3007

BME CORE		
Intro to BME	1	BME
Quant. Physiology	3	BME
Biomedical Imaging	3	BME
Instrumentation	3	BME
Molecular Biomedical Eng.	3	BME
Senior Design, Professionism, Ethics	6	BME
	19	
BME LABS		
Computer Applications for BME	1	
Instrumentation	1	BME
Cellular Engineering	3	BME
	5	

TRACKS	In collaboration with
Biomaterials	MSE
Biomechanics	MAE
Medical Imaging	NRE, CISE
Biomolecular	CHE
Neural Engineering	

	15
ELECTIVES	6
TOTAL CREDITS	132

Bachelor of Science in Biomedical Engineering ***Appendix C***

Plan of Study - standard

Name: _____ UFID: _____ Date _____

Suggested sequence

Course	CR	Course	Term	Comments/alternate course
Term 1				
MAC2311	4	Analytical Geometry and Calculus 1		*
CHM2045	3	General Chemistry		*/CHM2095
CHM2045L	1	General Chemistry Laboratory		CHM2095L/CHM2054L
BSC2010	3	Integrated Principles of Biology 1		*
BSC2010L	1	Biology 1 Lab		BSC2044L
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
Term Credit	15			
Term 2				
MAC2312	4	Analytical Geometry and Calculus 2		*/MAC2512+MAC2311AP
CHM2046	3	General Chemistry and Quantitative analysis		*/CHM2096
CHM2046L	1	General Chemistry and Quant Anal Lab		CHM2096L/CHM2054L
PHY2048	3	Physics with Calculus 1		*
PHY2048L	1	Laboratory for PHY2048		PHY2064L
BME1008	1	Introduction to Biomedical Engineering		
GenEd_HS	3	Humanities/Social & Behavioral Sciences		
Term Credits	16			
Term 3				
MAC2313	4	Analytic Geometry and Calculus 3		*
CHM3217	4	Organic Chemistry 1		CHM2210+CHM2211
PHY2049	3	Physics with Calculus 2		*
PHY2049L	1	Laboratory for PHY2049		PHY2064L
CGS2421	2	Computer programming for Engineers		
CSG2421L	1	Computer programming lab		
Term Credits	15			
Term 4				
MAP2302	3	Elementary Differential Equations		*
EEL3111C	4	Circuits 1		
PCB3XXX	4	Cell and Systems Physiology		*
BME3XXX	3	Energy Balance		*
Term Credits	14			
Lower Div	**60**			
Term 5		Summer semester		
ENC3254	3	Professional Writing for the Discipline		
EGM2511	3	Engineering Mechanics - Statics		
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
Term Credits	9			

Suggested sequence

Course	CR	Course	Term	Comments/alternate course
Term 6				
BME4503	3	Biomedical Instrumentation		
BME4503L	1	Biomedical Instrumentation Lab		
BME4XXX	3	Quantitative Physiology		
EMA3010	3	Materials		
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
BME Track	3			
Term Credits	16			
Term 7				
BME3323L	3	Cellular Engineering Lab		
BCH4024	4	Intro to Biochemistry and Molecular Biology		
EML3007	3	Elements of thermodynamics/heat transfer		EMA4314
BME Track	3			
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
Term Credits	16			
Term 8				
BME3XXX	1	Computer Applications for BME		
BME4531	3	Biomedical Imaging		
BME4882	3	Senior Design, Professionalism and Ethics 1		
BME4311	3	Molecular Biomedical Engineering		
BME Track	3			
BME Elective	3			
Term Credits	16			
Term 9				
BME4883	3	Senior Design , Professionalism and Ethics 2		
STA3032	3	Engineering Statistics		
BME Elective	3			
BME Track	3			
BME Track	3			
Term Credits	15			
Upper Div	**72**			
BSBME	**132**			

*Preprofessional Critical Tracking Courses, minimum GPA 3.0 (B)

GenEd: students must meet College of Engineering standards
Gordon Rule: students must meet University math and writing requirements
(PCB3XXX Cell and Systems Physiology: course at dept level approval, BME3XXX Energy Balance: course at dept level approval, BME3XXX Computer Applications for BME: course at dept level approval, BNE4XXX: Quantitative Physiology: course approved, awaiting SCNS number)

BME Tracks
15 credits of upper division courses in a specialization track are required. Courses are drawn from an approved list of electives per specialization track. The following tracks will be initially offered: Biomechanics – course selection from the biomechanics minor in MAE. Biomaterials – courses from the biomaterials track in MSE. Biomolecular – courses from the minor in biomolecular engineering in CHE, Imaging – existing courses from BME, NRE, CISE

Bachelor of Science in Biomedical Engineering ***Appendix C***

Plan of Study - transfer

Name: _____ UFID: _____ Date _____

Suggested sequence

Course	CR	Course	Term	Comments/alternate course
Term 1				
MAC2311	4	Analytical Geometry and Calculus 1		*
CHM2045	3	General Chemistry		*/CHM2095
CHM2045L	1	General Chemistry Laboratory		CHM2095L/CHM2054L
BSC2010	3	Integrated Principles of Biology 1		*
BSC2010L	1	Biology 1 Lab		BSC2044L
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
Term Credit	15			
Term 2				
MAC2312	4	Analytical Geometry and Calculus 2		*/MAC2512+MAC2311AP
CHM2046	3	General Chemistry and Quantitative analysis		*/CHM2096
CHM2046L	1	General Chemistry and Quant Anal Lab		CHM2096L/CHM2054L
PHY2048	3	Physics with Calculus 1		*
PHY2048L	1	Laboratory for PHY2048		PHY2064L
GenEd_HS	3	Humanities/Social & Behavioral Sciences		
Term Credits	15			
Term 3				
MAC2313	4	Analytic Geometry and Calculus 3		*
CHM2210	3	Organic Chemistry I		CHM2210+CHM2211
PHY2049	3	Physics with Calculus 2		*
PHY2049L	1	Laboratory for PHY2049		PHY2064L
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
COPXXXX	2	Computer programming		
Term Credits	16			
Term 4				
MAP2302	3	Elementary Differential Equations		*
CHM2211	3	Organic Chemistry II		
ENC2210	3	Technical Writing		
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
GenEd-HS	3	Humanities/Social & Behavioral Sciences		
Term Credits	15			

Course	CR	Course	Term	Comments/alternate course
Term 5		Summer semester		
EEL3111C	4	Circuits 1		
EMA3010	3	Materials		
EGM2511	3	Engineering Mechanics - Statics		
Term Credits	10			
Term 6				
BME4503	3	Biomedical Instrumentation		
BME4503L	1	Biomedical Instrumentation Lab		
PCB3XXX	4	Cell and Systems Physiology		*
BME4311	3	Molecular Biomedical Engineering		
BME1008	1	Introduction to Biomedical Engineering		
BME3XXX	3	Energy Balance		*
Term Credits	14			
Term 7				
BME3323L	3	Cellular Engineering Lab		
BCH4024	4	Intro to Biochemistry and Molecular Biology		
EML3007	3	Elements of thermodynamics/heat transfer		EMA4314
BME Track	3			
BME Track	3			
Term Credits	16			
Term 8				
BME3XXX	1	Computer Applications for BME		
BME4XXX	3	Quantitative Physiology		
BME4531	3	Biomedical Imaging		
BME4882	3	Senior Design, Professionalism and Ethics 1		
BME Track	3			
BME Elective	3			
Term Credits	16			
Term 9				
BME4883	3	Senior Design , Professionalism and Ethics 2		
STA3032	3	Engineering Statistics		
BME Elective	3			
BME Track	3			
BME Track	3			
Term Credits	15			

*Preprofessional Critical Tracking Courses, minimum GPA 3.0 (B)

GenEd: students must meet College of Engineering standards
Gordon Rule: students must meet University math and writing requirements

BME Tracks

15 credits of upper division courses in a specialization track are required. Courses are drawn from an approved list of electives per specialization track. The following tracks will be initially offered: Biomechanics – course selection from the biomechanics minor in MAE. Biomaterials – courses from the biomaterials track in MSE. Biomolecular – courses from the minor in biomolecular engineering in CHE, Imaging – existing courses from BME, NRE, CISE

Appendix D. Course descriptions

Mathematics

MAC 2311 Analytic Geometry and Calculus 1
Credits: 4;
Introduction to analytic geometry; limits; continuity; differentiation of algebraic, trigonometric, exponential and logarithmic functions; applications of the derivative; inverse trigonometric functions; differentials; introduction to integration; and the fundamental theorem of calculus.

MAC 2312 Analytic Geometry and Calculus 2
Credits: 4
Techniques of integration; applications of integration; differentiation and integration of inverse trigonometric, exponential and logarithmic functions; sequences and series.

MAC 2313 Analytic Geometry and Calculus 3
Credits: 4
Solid analytic geometry, vectors, partial derivatives and multiple integrals.

Physics

PHY 2048 Physics with Calculus 1
Credits: 3
The first of a two-semester sequence of physics for scientists and engineers. The course covers Newtonian mechanics and includes motion, vectors, Newton's laws, work and conservation of energy, systems of particles, collisions, equilibrium, oscillations and waves.

PHY 2048L Laboratory for PHY 2048
Credits: 1
Laboratory for PHY 2048

PHY 2049 Physics with Calculus 2
Credits: 3
The second of a two-semester sequence of physics for scientists and engineers. Content includes Coulomb's law, electric fields and potentials, capacitance, currents and circuits, Ampere's law, Faraday's law, inductance, Maxwell's equations, electromagnetic waves, ray optics, interference and diffraction.

PHY 2049L Laboratory for PHY 2049
Credits: 1
Laboratory for PHY 2029

Chemistry

CHM 2045 General Chemistry 1

Credits: 3

The first semester of the CHM 2045-2045L-2046-2046L sequence. Stoichiometry, atomic and molecular structure, the states of matter, reaction rates and equilibria.

CHM 2045L General Chemistry 1 Laboratory

Credits: 1

Laboratory experiments designed to reflect the topics presented in CHM 2045.

CHM 2046 General Chemistry 2

Credits: 3

The second semester of the CHM 2045, 2045L,CHM 2046, 2046L sequence. Students who completed 2045 (or equivalent) at another institution should consult a chemistry adviser before registering for this course. Acids and bases, additional aspects of chemical equilibria, thermodynamics, electrochemistry, complex ions and descriptive chemistry.

CHM 2046L General Chemistry 2 Laboratory

Credits: 1

Laboratory experiments designed to reflect the topics presented in CHM 2046.

CHM 3217 Organic Chemistry/Biochemistry 1

Credits:

A rigorous, one semester overview of the structure, properties and reactions of organic compounds. This is the first half of a two-semester sequence in biochemistry.

BCH 4024 Introduction to Biochemistry and Molecular Biology

Credits: 4

An introduction to physical biochemistry, intermediary metabolism and molecular biology. Topics include a survey of structure, chemistry and function of proteins and nucleic acids, enzyme kinetics and mechanisms of catalysis; a survey of the pathways of carbohydrate, lipid and nitrogen metabolism and their metabolic control; regulation of gene expression at the level of DNA, RNA, and protein synthesis.

Biology

BSC 2010 Integrated Principles of Biology 1

Credits: 3

A study of the origin of life systems; of biological molecules, and organization of living things at the subcellular, cellular and organismic levels; and of the

activities of living forms in obtaining and utilizing energy and materials in growth, maintenance and reproduction.

BSC 2010L Integrated Principles of Biology Laboratory 1
Credits: 1
Laboratory experiments designed to accompany BSC 2010.

PCB 3XXX Cell & Systems Physiology
Credits: 4
Basic quantitative physiology course.

Statistics

STA 3032 Engineering Statistics
Credits: 3
A survey of the basic concepts in probability and statistics with engineering applications. Topics include probability, discrete and continuous random variables, estimation, hypothesis testing, and linear and multiple regression.

Engineering Core

BME 2XXXL Programming for BME
Credits: 1
Programming laboratory course with applications to Biomedical Engineering. Data processing, control techniques and simulation programs.

BME 3XXX Energy Balances
Credits: 3
Energy Balance for BME

CGS 2421 Computer Programming for Engineers
Credits: 2
Computer programming and the use of computers to solve engineering and mathematical problems. Emphasis will be placed on applying problem solving skills. This intensive course is specifically directed towards those students who are pursuing technical careers in fields employing a reasonably high degree of mathematics. The programming language used will depend on the demands of the departments in the college. In one semester, several languages may be taught, no more than one per section. Students required to learn a specific language must enroll in the correct section.

EML 3007 Elements of Thermodynamics and Heat Transfer
Credits: 3
Applications of first and second laws of thermodynamics to closed and open systems. Steady one-dimensional conduction, lumped parameter analysis, convection, radiation. Intended for non-mechanical engineering students.

EGM 2511 Engineering Mechanics-Statics
Credits: 3
Reduction of force systems. Equilibrium of particles and rigid bodies. Vector methods. Application to structures and mechanisms.

EMA 3010 Materials
Credits: 3
Conceptual perspective for origin of materials behavior - structure/property/performance interrelationships. Materials selection and use of familiar material - metals, ceramics, polymers, electronic materials and composites in electronics, structural and other engineering applications.

EEL 3111C Circuits 1
Credits: 4
Basic analysis of DC and AC electric circuits. Laboratory.

BME Core

BME 1008 Introduction to Biomedical Engineering
Credits: 1
This is an introduction to and overview of Biomedical Engineering. Lectures will be given by faculty of the Biomedical Engineering Department at the University of Florida. Topics will include a survey of human systems (e.g. cardiovascular, musculoskeletal, and central nervous system), diseases and injuries that affect them and approaches used by Biomedical Engineers to repair the system.

BME 3XXX Quantitative Physiology
Credits: 3
Quantitative modeling of organ system physiology of the nervous system, the cardiovascular system and the respiratory system will be discussed and students will work on quantitative problems.

BME 3323L Cellular Engineering Laboratory
Credits: 3
The Cellular Engineering Laboratory will teach students the fundamentals of cell culture for use in Biomedical Engineering investigations. Students will acquire skills in cell culture, quantitative analyses, notebook keeping, report writing and oral presentation.

BME 4311 Molecular Biomedical Engineering
Credits: 3
An introductory course in the fundamentals of Molecular Biology for Biomedical Engineers. This course is designed for Junior or Senior biomedical engineering students where they will learn the nomenclature, and current state of knowledge of the eukaryotic cell and it's related structures. Topics

covered in this course: Protein structure and function, Enzymes. The structure and nature of DNA, cellular structure and function of various cellular organelles. In addition they will learn energy and the function of mitochondria and chloroplast, cellular communication, and the function of the extracellular matrix.

BME 4531 Medical Imaging
Credits: 3
This course covers modern medical imaging technologies from a biomedical engineering perspective. The physics, mathematics, instrumentation and clinical applications of all common medical imaging modalities including x-ray radiography, computed tomography (CT), ultrasound imaging, positron emission tomography (PET), and magnetic resonance imaging (MRI) will be discussed. Emerging imaging modalities including optical imaging, fluorescence imaging and photoacoustic imaging will also be introduced.

BME 4503 Biomedical Instrumentation
Credits: 3
This course covers engineering and medical bases of application, measurement and processing of signals to and from living systems. Biomedical transducers for measurements of movement, biopotentials, pressure, flow, concentrations, and temperature are discussed, as well as treatment devices such as ventilators and infusion pumps.

BME 4503L Biomedical Instrumentation Laboratory
Credits: 2
Laboratory to go with BME4XXX Biomedical Instrumentation. Students will put into practice what they learn in the course

BME 4882 Senior Design, Professionalism, and Ethics 1
Credits: 3
Design of custom strategies to address real-life issues in the development of biocompatible and biomimetic devices for biotechnology or biomedical applications. Student teams will work with a client in the development of projects that incorporate various aspects of biomedical engineering including instrumentation, biomechanics, biotransport, tissue engineering, and others. Formal engineering design principles will be emphasized; overview of intellectual properties, engineering ethics, risk analysis, safety in design and FDA regulations will be reviewed. Oral and written reports, and prototype design will be required. This course is intended as a capstone design course for the upper-level undergraduate biomedical engineering students. In the fall semester, the emphasis will be on project identification, problem statement, and solution design, and project proposal.

BME 4883 Senior Design, Professionalism, and Ethics 2
Credits: 3

Design of custom strategies to address real-life issues in the development of biocompatible and biomimetic devices for biotechnology or biomedical applications. Student teams will work with a client in the development of projects that incorporate various aspects of biomedical engineering including instrumentation, biomechanics, biotransport, tissue engineering, and others. Formal engineering design principles will be emphasized; overview of intellectual properties, engineering ethics, risk analysis, safety in design and FDA regulations will be reviewed. Oral and written reports, and prototype design will be required. This course is intended as a capstone design course for the upper-level undergraduate biomedical engineering students. In the spring semester, the emphasis will be on prototype development and design implementation, design and prototype testing and benchmarking, troubleshooting and redesign, and final working prototype and design demonstrations.