New Program Request

Master of Science / Master of Engineering
in
Biomedical Engineering

Southern Illinois University Carbondale
College of Engineering

November 2006

REQUEST FOR A NEW UNIT OF INSTRUCTION

M.S. / M.E. in Biomedical Engineering

TABLE OF CONTENTS

APPENDICES

REQUEST FOR A NEW UNIT OF INSTRUCTION

BACKGROUND

1. Name of Institution: Southern Illinois University Carbondale

2. Title of Proposed Program: M.S. / M.E. in Biomedical Engineering

3. Contact Person: William P. Osborne, Dean, College of Engineering

3.1. Telephone: (618) 453-4321
3.2. E-mail: wosborne@engr.siu.edu
3.3. Fax: (618) 453-7455

4. Level of Proposed Unit: Master of Science

5. Requested CIP Code:

6. Proposed Date for Enrollment: Fall Semester following the program approval.

7. Location Offered: On-Campus

MISSION, OBJECTIVES AND PRIORITIES

8. Mission

8.1. Specific Objectives and Measurable Contributions to the University's Mission

The objective of the College of Engineering is to enhance Biomedical Engineering education and research at SIUC. The plan of the College (depicted in Figure 1.) consists of two steps. The first step, which is addressed in this proposal, is the establishment of Masters-Level Degrees (Master of Science and Master of Engineering) in Biomedical Engineering. This will facilitate the much desired collaboration among the Colleges of Engineering, Science, Agricultural Sciences and the School of Medicine in the areas of research and graduate education. The new graduate courses in biomedical engineering will enhance the already successful Ph.D. program in Engineering Science and will make possible the development of a MD/PhD track in Engineering Science. The second step will be the establishment of an accredited BS program in Biomedical Engineering with a Premed Track. This step can be achieved with a modest incremental cost following the successful establishment of the MS and ME programs in Biomedical Engineering.

Biomedical Engineering has been the fastest growing engineering discipline over the past twenty-five years. The undergraduate and graduate enrollments in bioengineering and the corresponding enrollments in all other engineering disciplines for the period 1979-2003 are depicted in Figure 2. The graphs show that while the undergraduate enrollment in all engineering fields remained essentially constant from 1995 to 2003, the BME undergraduate enrollment has doubled during the same period. Similarly, during the same period the BME graduate enrollment has doubled while the graduate enrollment for all engineering has increased by only twenty-five per cent.

The future demand for biomedical engineers with undergraduate and especially with graduate degrees will grow even faster than the past decade. The Occupational Outlook Handbook, 2006-07 Edition, published by the United States Department of Labor http://www.bls.gov/oco/ocos027.htm gives the following prediction:

"**Biomedical engineers** are expected to have employment growth that is much faster than the average for all occupations through 2014. The aging of the population and the focus on health issues will drive demand for better medical devices and equipment designed by biomedical engineers. Along with the demand for more sophisticated medical equipment and procedures, an increased concern for cost-effectiveness will boost demand for biomedical engineers, particularly in pharmaceutical manufacturing and related industries. However, because of the growing interest in this field, the number of degrees granted in biomedical engineering has increased greatly. Biomedical engineers, particularly those with only a bachelor's degree, may face competition for jobs. Unlike the case for many other engineering specialties, **a graduate degree is recommended or required for many entry-level jobs."**

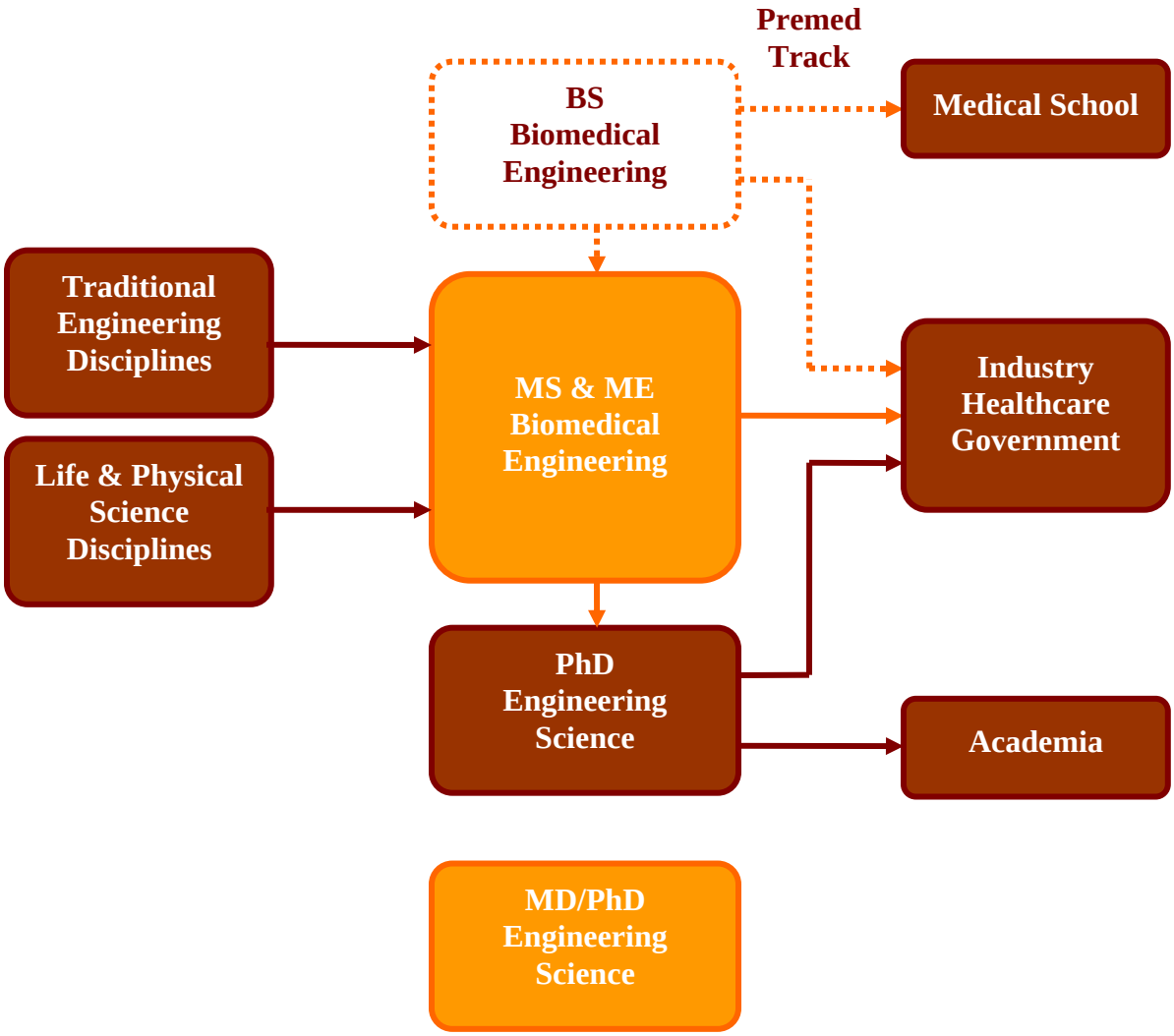


Figure 1. Plan for enhancing Biomedical Engineering education and research at SIUC

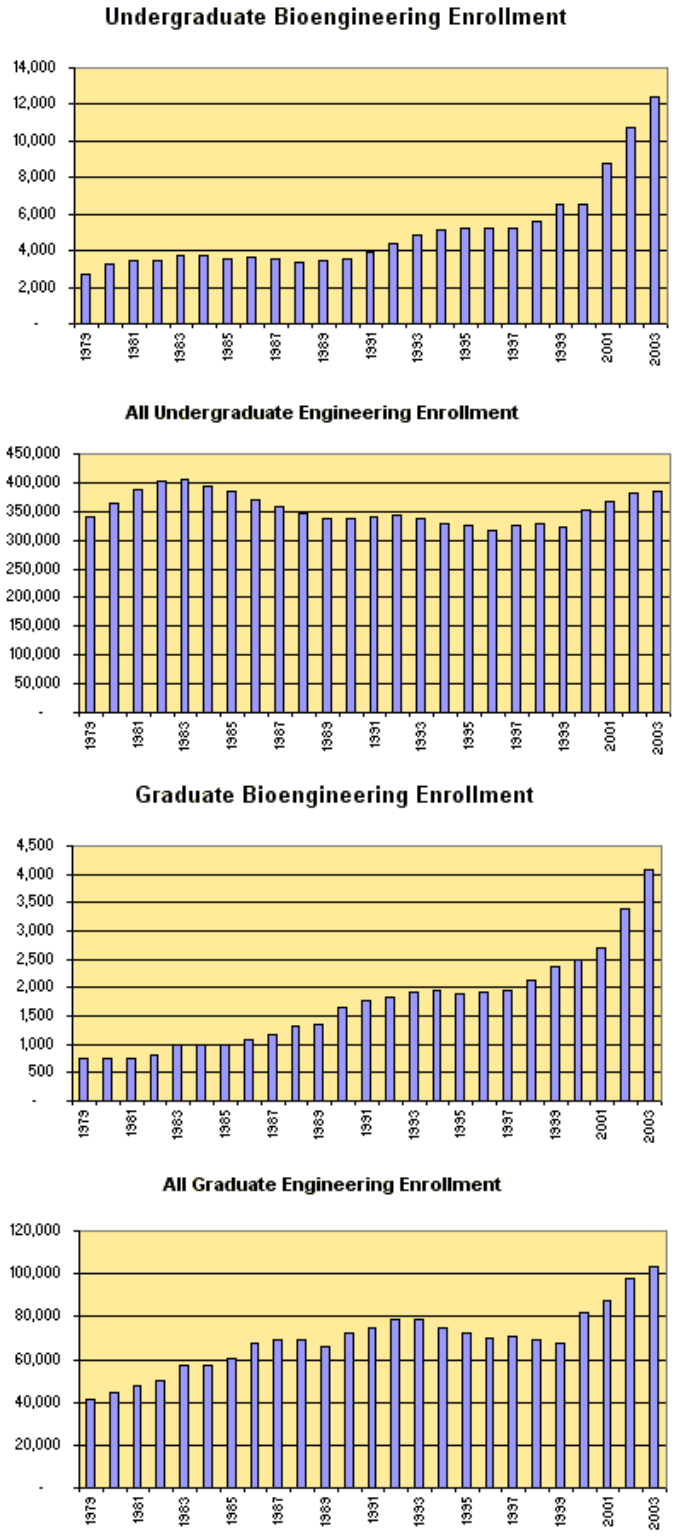


Figure 2. Growth of Bioengineering enrollment during the period 1979 to 2003.
Source: Engineering Workforce Commission of the American Association of Engineering Societies. © 2006 The Whitaker Foundation.

Similar and even more optimistic projections regarding the demand for biomedical engineers, both with undergraduate and graduate degrees, are given by several other sources such as the Biomedical Engineering Society http://www.bmes.org/, more specifically the Careers Planning Section http://www.bmes.org/careers.asp, the Biomedical Engineering Network http://www.bmenet.org/BMEnet/ and the Whitaker Foundation - http://www.whitaker.org/index.html. A wealth of information regarding the future demand, the future trends and the planning considerations for Biomedical Engineering education can be found in the presentations of the 2005 Biomedical Engineering Summit. http://www.whitaker.org/academic/wrapup.html. The curriculum database http://bluestream.wustl.edu/whitaker/ for all major programs in the country has been consulted in the course of the development of this proposal, along with the latest innovations http://www.whitaker.org/innovations/ in Biomedical Engineering education.

From the analysis and data presented above, it is evident that the proposed program is indeed consistent with the University's focus statement and priorities and that it will make measurable contributions to the mission of the institution in the following ways:

- Provide students with diverse academic backgrounds (life sciences, physical sciences, medicine, psychology and all traditional engineering disciplines) with the opportunity to develop expertise and pursue rewarding careers in this promising and rapidly expanding area of Biomedical Engineering.

- Because of the complexities involved and critical importance of its applications, biomedical engineering employment increasingly requires graduate level education, even for entry-level jobs. This trend will continue for the foreseeable future. Thus, the demand for graduates with MS, ME and PhD degrees will increase even faster than the demand for graduates with BS degrees.

- One of the most important contributions (perhaps the most important) of the proposed program is that it will create a focal point for technical interaction and collaboration in interdisciplinary research among faculty from the School of Medicine and Colleges of Engineering, Science, Agricultural Sciences and other related disciplines, such as Psychology. Federal, state and industry funds designated for biomedical engineering related research are by far higher than most other research areas. The National Institutes of Health (NIH), major sponsor of biomedical research, has a much larger budget than all other federal funding agencies. Collaboration and interdisciplinary research in this area will help the School of Medicine and all the Colleges involved, to reach their full potential in the area of funded research and in doing so, to achieve the funded research goal of "Southern 150" http://news.siu.edu/s150/ which is one of the most important goals of the University.

- In conclusion, the proposed program, by utilizing ***existing campus-wide resources*** and with a modest incremental cost, will increase the number of graduate students (both at the Masters and Doctoral levels) in a high demand emerging field of study. At the same time this initiative will create the conditions for successful multidisciplinary research in an area with high potential of external funding.

8.2. Meeting Regional and State Needs and Priorities

In February 1999 the State of Illinois developed and published the strategic plan for higher education entitled **"The Illinois Commitment: Partnerships, Opportunities and Excellence."** http://www.ibhe.state.il.us/board/agendas/1999/february/1999-02-07.pdf

The Mid-Term Review of "The Illinois Commitment," in 2004 included the assessment of achievements, challenges, and stakeholder opinions. The conclusion was that the six goals, articulated in the original plan, have served the State well and should be retained. http://www.ibhe.state.il.us/board/agendas/2004/april/bdpresent opinions 4-04.ppt

With reference to the above, the proposed program in biomedical engineering is consistent with and contributes to five of the six goals of the "**Illinois Commitment**:"

Economic Growth (Goal 1): The anticipated substantial increase in research and development funds will contribute to the economic development of the region. The number of businesses that will be served by the University will increase by adding the sector of biomedical engineering. Thus, the program will expand the University partnership with businesses to jointly pursue research in this promising area. The number of SIUC graduates with the skills and knowledge needed to meet new and emerging occupational demand will certainly increase with the development of the biomedical engineering field.

Affordability (Goal 3): As a graduate program in a research intensive area, biomedical engineering is expected to generate sufficient research funds to support many of the students. Almost all in-state students and many out-of-state students are expected to be provided with an assistantship during the course of their studies. Thus, the program will provide a diverse body of students with the opportunity to study and to develop expertise in this emerging area at a minimal cost or even at no cost at all.

Access and Diversity (Goal 4): The success of SIUC and particularly the success of the College of Engineering in achieving diversity in its student body is an indication that biomedical engineering will have similar success, since it will draw its students from the undergraduate population. The University's commitment to continuously improve diversity and aggressive programs such DFI will certainly benefit from the biomedical engineering initiative.

High Expectations and Quality (Goal 5): The College of Engineering and all Engineering Departments have developed a sophisticated program review and program improvement system, based on outcomes assessment, with multiple inputs from both internal and external sources. This system will be adapted and used for the proposed program. More details regarding quality assurance will be given in section 13.

Productivity and Accountability (Goal 6): The conceptual design of the program is based on the utilization of existing resources (courses already offered by various units across campus), to minimize cost and maximize productivity. The modest incremental

funding requested is needed for additional faculty (from reallocation in the College of Engineering and the existing "Faculty Hiring Initiative") faculty support (particularly laboratories) necessary to establish and teach a core of biomedical engineering courses (not currently offered) and to provide research guidance to biomedical engineering students. The program will be administered by the Office of the Dean of Engineering with minimal additional cost.

8.3. Similar Programs in the State

In the State of Illinois, Masters-level biomedical engineering programs are currently offered by UIC and UIUC among the State Institutions and by Northwestern University. Biomedical engineering programs are a cost-effective proposition for institutions which have both medical and engineering schools, because they can utilize existing capacity and resources. SIUC is the only University in the State with both Medical and Engineering Schools that does not offer Biomedical Engineering degrees. The proposed program, therefore, will simply increase the productivity of the university by better utilizing existing resources, increase funded research and provide opportunity to a diverse body of students to specialize in an emerging area of technology.

Biomedical Engineering, especially at the graduate level, covers a wide spectrum of applications involving many technical disciplines. For this reason all graduate curricula in the area of biomedical engineering are extremely flexible with a very minimal required component and a wide range of science and engineering electives. In fact graduate biomedical engineering programs, within the limitations imposed by the number and the areas of expertise of the faculty, are designed to meet the background and interests of each individual student. In view of the above and since each program reflects the specific areas of expertise and interests of its faculty, the proposed program is not likely to duplicate or to adversely impact any other existing programs.

8.4. Estimated Future Employment Opportunities

The growth of biomedical engineering demand over the past twenty-five years and the predictions for future demand have already been discussed in the beginning of this section. The United States Department of Labor projects that number of biomedical engineering jobs will increase by 31.4% through 2010 (double the rate of all other jobs combined) http://www.bmes.org/careers.asp. The number of biomedical engineering jobs requiring a graduate degree (particularly at the Masters-Level) will grow even faster, because of the high level of expertise needed to deal with applications and procedures involving human health. http://www.bls.gov/oco/ocos027.htm. Specific growth areas cited in the report of the Department of Labor include computer-assisted surgery, cellular and tissue engineering, rehabilitation, and orthopedic engineering. The Projections for the State of Illinois are similar to the National projections. The "State Occupational Projections" website http://www.projectionscentral.com/projhome.asp projects a 23% increase of biomedical engineering jobs in Illinois through 2012. Talented Illinoisans, who would otherwise seek opportunities in biomedical engineering out-of-state, will be able to receive training and find employment in the State. The graduates from the

proposed program, therefore, are expected to have both excellent employment opportunities and rewarding careers. In view of the above it is also evident that the proposed program will not have any negative impact on the employment opportunities of the graduates from other programs in the State.

9. Program Description

9.1. Academic Objectives, Curriculum Structure, Catalog Description

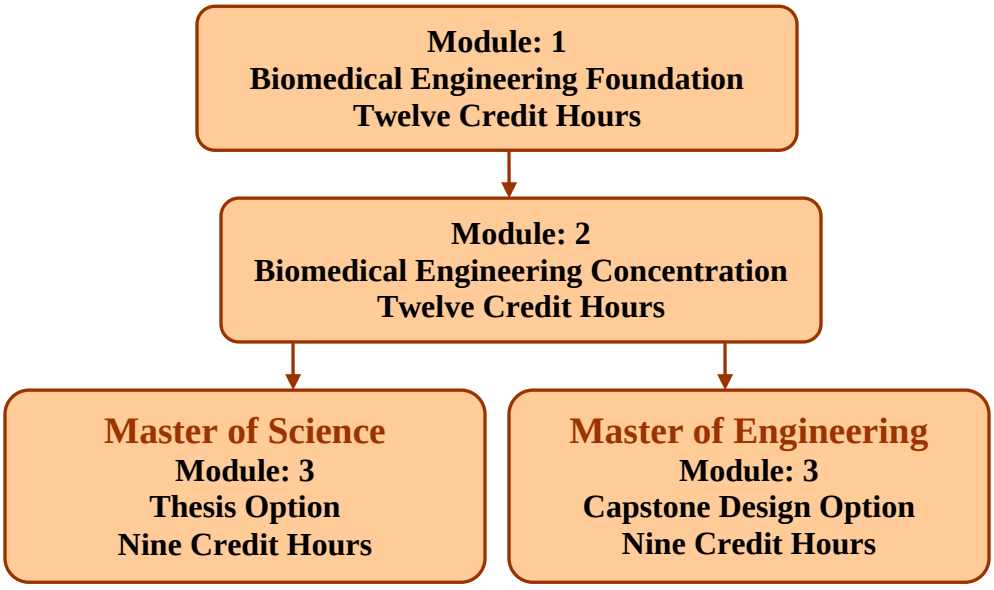
The proposed program, consistent with the mission and priorities of the University, is designed to achieve the following academic objectives:

- To provide high quality education in the field of biomedical engineering and to prepare the graduates for successful and rewarding employment as engineers or for continuing their education through the doctoral level.

- To provide the students with the training necessary to successfully apply the fundamental concepts and methods of biomedical engineering to selected areas of employment or research and development.

- To enhance the research environment and productivity of the College of Engineering, and all other units participating in the program. This in turn will positively contribute to the efforts of the University to enhance its research ranking and its national visibility as a major research institution.

To achieve these academic objectives and to provide a diverse student body with the opportunity to enroll in the program, the curriculum is structured in three modules:



Module 1. Biomedical Engineering Foundation 12 Semester Credit Hours

This module is required for all biomedical engineering students and is designed to provide the background necessary for all areas of specialization offered by the program. The module consists of six hours of analytical foundation and six hours of science foundation. The analytical foundation consists of the following courses:

BME 501	Statistics for Biomedical Engineers	3 hours
ENGR 521	Probability and Random Variables	3 hours

All engineering majors and most, if not all, science majors have the background necessary to enroll in these courses. Students that do not have the prerequisite knowledge to enroll in these courses may be admitted to the program with the requirement to take additional mathematics background courses.

The science foundation requires at least six hours selected from the following courses offered by the Departments of Physiology, Chemistry and Biochemistry.

PHSL 410A	Mammalian Physiology	4 hours
PHSL 410B	Mammalian Physiology	4 hours
CHEM 444	Intermediate Organic Chemistry	3 hours
CHEM 451	Biochemistry	3 hours

The selection of the science courses must be approved by the program coordinator based on the student's academic background and desired area of specialization. The courses above are expected to be selected most of the time, however, (with the approval of the program coordinator) students may select other science courses that better complement their background or better serve their area of interest. The requirement for six hours of science will be waived for students with Bachelor of Science degree in Biomedical Engineering, however, these students will be expected to take three hours of additional engineering courses to meet the requirements of the Graduate School for MS degrees.

Module 2. Biomedical Engineering Concentration 12 Semester Credit Hours

This Module includes the 500-level BME courses and 500-level courses related to biomedical engineering, offered by different units on campus (referred to as BME-related courses in this proposal).

The initial areas of concentration, selected in such a way as to fully utilize existing faculty resources and minimize the number of new faculty required, are as follows:

- Bioinformatics & Computational Medicine
- Modeling and Simulation of Biomedical Processes
- Biomedical Imaging
- Biomedical Instrumentation
- Biomechanics and Biomaterials

The list of courses (BME and BME-related) for each of these five areas of concentration is presented in Appendix I. The list of the existing BME-related courses (grouped by academic unit) is presented in Appendix II. The list of the new courses proposed to be established (with prefix BME) and their descriptions are presented in Appendix III. The students, normally, are expected to select all twelve hours from one of the concentrations. With the approval of their advisor, however, students may select nine hours from the concentration only, and three hours as a free elective. Finally, with the approval of the Program Coordinator, students may select any combination of courses, depending on their background or their specific interests. In all cases, however, at least six hours must always be selected from BME courses.

Module 3. Biomedical Research or Capstone Design 9 Semester Credit hours

Master of Science Option (M.S.)

For the students seeking a Master of Science Degree in Biomedical Engineering, this module consists of the following:

BME 599	Thesis	6 hours
BME 598	Biomedical Engineering Seminar	2 hours
BME 597	Biomedical Research Ethics	1 hour

All requirements and regulations regarding the Thesis (as is the case with all the other Master's degrees in traditional engineering disciplines) will be consistent with the relevant policies and procedures of the Graduate School published in the graduate catalog. One hour of Biomedical Engineering Seminar BME 598 must be taken in the first semester of study to serve as introduction to biomedical engineering.

Thus, students with BS degrees in traditional engineering disciplines or computer science are expected to complete the requirements of the program with thirty-three hours. Students with BS degree in biomedical engineering will require thirty hours. For students with BS degrees in other than engineering disciplines, it is possible that more than thirty-three hours will be needed, depending on the background and interests of the student. This will be assessed, for each student individually, at the time of admission.

Master of Engineering Option (M.E.)

For the students seeking a Master of Engineering Degree in Biomedical Engineering, this Module consists of the following:

BME 592	Capstone Design	3 hours
BME 598	Biomedical Engineering Seminar	2 hours
BME 597	Biomedical Research Ethics	1 hour
Approved	Elective Course	3 hours

BME 592, Capstone Design, must involve substantial design in a biomedical engineering field and must be concluded with a technical report. The report both in terms of technical content and presentation must be approved by a three member faculty committee appointed and chaired by the faculty member who directed the project. One hour of Biomedical Engineering Seminar BME 598 must be taken in the first semester of study to serve as introduction to biomedical engineering. For students with BS in engineering the Elective Course must be at the 500-level if an Engineering course, otherwise it could be at the 400-level. For students with BS in Science the Elective Course must be at the 500-level if a science course, otherwise it could be at the 400-level. In any event, the Elective Course must be approved by the program coordinator.

Thus, students with BS degrees in traditional engineering disciplines or computer science are expected to complete the requirements of the program with thirty-three hours. Students with BS degree in biomedical engineering will require thirty hours. For students with BS degrees in other than engineering disciplines, it is possible that more than thirty-three hours will be needed, depending on the background and interests of the student. This will be assessed, for each student individually, at the time of admission.

The list of all existing courses, referenced in this proposal as BME-related courses, is presented in Appendix II. The descriptions of all new courses, proposed to be established with this proposal, are presented in Appendix III.

Admission Requirements

Admission to the program requires a Bachelor of Science degree in Engineering, Sciences, or a related field with a GPA of 3.25 / 4 or higher. Applications for admission must include the following: A statement of interest, transcripts, GRE scores, three reference letters and TOEFL score (where appropriate), as required by the Graduate School. The application fee for all applicants, and any other documentation specifically required for international students will be in accordance with the requirements of the Graduate School. Admission to the program is made by the Dean of Engineering (or his designee) upon recommendation of the Program Committee.

Program Administration

The program Committee shall consist of six faculty members (designated by their respective Deans), one from the School of Medicine, one from each of the Colleges of Science and Agricultural Sciences and three from the College of Engineering. The Dean of Engineering shall appoint one of the members as Committee Chair and Program Coordinator.

The Program Committee, in addition to recommending on admissions, shall review the program, conduct the outcomes assessment process and make recommendations for the continuous improvement of the program.

The Program Coordinator will be responsible for advising new students and assisting them with their initial plan of study. The Program Coordinator will also act as graduate advisor to all students until a faculty advisor is assigned to them, and will be responsible for the day-to-day operation of the program. The semester credit hours taught in the framework of the program will be credited to the unit offering the course.

9.2. Program Outcomes

The graduates from the M.S. and M.E. programs in Biomedical Engineering will be expected to develop and demonstrate the following abilities:

- To successfully apply analytical methods (especially probability and statistics) to biomedical engineering problems.

- To successfully apply engineering methods, including modeling, simulation and design to biomedical problems.

- To communicate in clear and concise technical language and to effectively present their research or design results.

- To understand the basic concepts, tools and methodology of research. This will help them in successfully pursuing doctoral studies.

The degree of achievement of these outcomes will be continuously assessed using the processes described in section 13. The results of the assessment will be used to continuously improve the program.

9.3. Strategies to Promote Learning

The students expected to be admitted to this program will be highly motivated and exceptionally qualified; therefore, there is no need for specific strategies to promote student learning, beyond the traditional approach used in graduate studies.

RESOURCES

10. Enrollment Projections

Projections regarding the student enrollments, semester credit hour generation and degrees awarded during the first five years of the new program are shown in Table I.

Table I

Student Enrollment Projections for the New Program

	Budget Year	2nd Year	3rd Year	4th Year	5th Year
Number of Program Majors *	20	50	80	80	80
Annual Full-Time-Equivalent Majors	20	50	80	80	80
Annual Credit hours in Existing Courses	140	360	580	580	580
Annual Credit Hours in New Courses	440	1080	1720	1720	1720
Annual Number of Degrees Awarded	---	15	25	40	40

* Fall Semester headcount

The number of credit hours in existing courses refers to the hours generated by the proposed program only (thus represents the increase in credit hours as a result of the proposed program). This number is relatively small compared to the total number of credit hours generated by the existing courses, which are offered by many different units on Campus and are taken by many majors both at the undergraduate and graduate levels.

The number of credit hours in new courses refers to the total number of hours expected to be generated by these courses. It is anticipated that approximately fifty percent of the hours will be generated by the majors of the proposed program and the other fifty percent will be generated by majors in other MS and PhD programs, in engineering taking these courses as electives.

Based on the structure of the curriculum (discussed in the previous section), it is expected that the Biomedical Engineering majors will be taking approximately forty percent of their credit hours from existing courses (listed in Appendix II) and the other sixty percent from new courses (listed in Appendix III), including thesis and special investigation hours.

Although nominally the program minimum requirements are thirty-three hours for students with BS degrees in traditional engineering disciplines and thirty hours for students with BS degree in biomedical engineering, the average student is expected to require approximately thirty-six hours.

The entries in Table I reflect the assumptions discussed above and thus provide a fairly accurate measure of the anticipated productivity of the proposed program. Note that this program will generate approximately $1.25 M in new tuition income for the University when it matures in its third year.

11. Resource Requirements

Table II

Total Resource Requirements for the New Program

		Current Year	Budget Year	2nd Year	3rd Year	4th Year
1	Total Resource Requirements	560,000	726,000	826,000	926,000	926,000
2	Resources Available from Federal Sources	---	---	---	---	---
3	Resources Available from Other Non-State Sources	---	---	---	---	---
4	Existing State Resources	560,000	560,000	726,000	826,000	926,000
5	Resources Available from Internal Reallocation	---	166,000	100,000	100,000	---
6	New State Resources Required	---	---	---	---	---
Breakdown of Resources from Internal Reallocation						
7	FTE Staff	---	1.25	2.25	3.25	---
8	Personnel Services	---	116,000	196,000	276,000	---
9	Equipment	---	50,000	70,000	90,000	---
10	Library	---	---	---	---	---
11	Other Support Services	---	---	---	---	---

The entry under Existing State Resources in the “Current Year” (Table II) represents the contributions of existing units across Campus to the program, through better utilization of their capacity and resources.

The entries “Resources Available from Internal Reallocation” are analyzed as follows:

Budget Year: New recurring funds from internal reallocation: $166,000

- One faculty member at the Assistant Professor level: $80,000
- One senior faculty member at 0.25 FTE as Program Coordinator: $36,000
- Equipment funds to develop BME the Labs: $50,000

Second Year: **New recurring funds from internal reallocation:** **$100,000**

- One faculty member at the Assistant Professor level: $80,000
- Equipment funds to develop BME the Labs: $20,000

Third Year: **New recurring funds from internal reallocation:** **$100,000**

- One faculty member at the Assistant Professor level: $80,000
- Equipment funds to develop BME the Labs: $20,000

The total new funds from internal reallocation (when the program reaches its steady-state) is $366,000, which represents approximately twenty-five percent of the tuition income anticipated to be generated by the program. Thus, in addition to all the other contributions already discussed, the proposed program will have a positive impact on the tuition income fund of the University. However, as everyone knows the University Budget is in stress and this money may not be available for reallocation within the University; if that is the case, the College will fund this program by reallocating its internal resources.

The new faculty members, all with Biomedical Engineering Background, will be assigned to the ECE or ME Departments (depending on their area of expertise) and will be responsible for the development and teaching the new courses and for developing biomedical engineering research in collaboration with the existing faculty members. The new faculty and some of the existing faculty will form the nucleus of the Biomedical Engineering Department when a BS Degree in Biomedical Engineering is established in the future. From the analysis presented above, with an incremental cost of $366,000 the University will generate approximately 2,300 new credit hours. The cost, less than $160 per credit hour, is less than forty percent of the State Norm for graduate credit hours in engineering.

12. Institutional Resources Available

The Institutional resources necessary for developing and maintaining a high quality program in Biomedical Engineering are in place. More specifically:

Faculty: The Colleges and Departments proposing to participate in the program have outstanding faculty and are among the most productive units on Campus in the areas of externally funded research and graduate education. A list of existing faculty members, expected to contribute to the program, is presented in Table III. The commitment and support of all units expected to participate is indicated in their letters of support, which are included in Appendix IV, along with letters of support from biomedical engineering related industries.

Library: The Library and campus computing resources are excellent, and certainly are more than adequate for supporting the quality of the program. The letter of support from the Dean of Library Affairs (Appendix IV) includes data regarding the resources available in terms of books, journals and electronic data bases.

Table III

Faculty in Existing Academic Units Expected to Contribute to the Program

Name	College	Technical Area	Home Page
Botros N.	Engineering	Instrumentation	http://www.engr.siu.edu/elec/
Sayeh, M	Engineering	Sensors	http://www.engr.siu.edu/elec/
Kagaris, D.	Engineering	Bioinformatics	http://www.engr.siu.edu/elec/
Viswanathan, R.	Engineering	Statistics	http://www.engr.siu.edu/elec/
Gupta, L.	Engineering	Image processing	http://www.engr.siu.edu/elec/
Tragoudas, S.	Engineering	Bioinformatics	http://www.engr.siu.edu/elec/
Yen, S.	Engineering	Materials	http://www.engr.siu.edu/elec/
Wittmer, D.	Engineering	Stress Analysis	http://www.engr.siu.edu/elec/
Mahajan, A.	Engineering	Sensors	http://www.engr.siu.edu/elec/
Blackburn, J.	Engineering	Bioprocesses	http://www.engr.siu.edu/elec/
Filip, P.	Engineering	Light Microscopy	http://www.engr.siu.edu/elec/
Mohanty, M.	Engineering	Statistics	http://www.engr.siu.edu/elec/
Zhu, M.	Science	Bioinformatics	http://www.cs.siu.edu/
Wainer, M.	Science	Bioinformatics	http://www.cs.siu.edu/
Steger, R.	Medicine	Endocrinology	http://www.som.siu.edu/physiology/
Kohli, P.	Science	Nanotechnology	http://www.science.siu.edu/chemistry/
Dyer, D.	Science	Chemistry	http://www.science.siu.edu/chemistry/
McCarroll,M.	Science	Instrumentation	http://www.science.siu.edu/chemistry/
Gao, Y.	Science	Nanomaterials	http://www.science.siu.edu/chemistry/
Aouadi, S.	Science	Applied Physics	http://www.physics.siu.edu/
Achenbach, L	Science	Biology	http://www.siuc.edu/%7Eanthro/
Kelly, A.	Science	Fish Physiology	http://www.science.siu.edu/zoology/
Ford, S.	Liberal Arts	Anthropology	http://www.siuc.edu/%7Eanthro/
Wood, A.	Science	Genetics	http://www.science.siu.edu/plant-biology/
Lightfoot, D.	Agriculture	Genetics	http://www.siuc.edu/~psas/
Meksem K.	Agriculture	Genetics	http://www.siuc.edu/~psas/
Douglas S.	Liberal Arts	Cognitive Science	http://www.psychology.siu.edu/
Paliwal, M.	Medicine	Biostatistics	http://www.siumed.edu/surgery/dept/
Schwartz, B.	Medicine	Endourology	http://www.siumed.edu/surgery/dept/

Support: The Colleges of Engineering, Science, Agricultural Sciences and the Medical School, have excellent college and departmental research laboratory facilities in many of the areas relevant to the proposed program. In some areas related to biomedical engineering these academic units, indeed, have national and international visibility. In addition the University has outstanding central facilities, such as the Materials Technology Center, the DNA Sequencing & DNA Marker Analysis Facility, Genomics and Robotics Services, Image-Integrated Microscopy Center and Nuclear Magnetic Resonance (NMR) Facility.

QUALITY ASSURANCE

13. Program/Student Learning Outcomes Assessment

13.1. Assessment Plan

The Objective of the program is to train top class biomedical engineers, capable of life long learning, to meet the needs of the present and the challenges of the future in Industry, Healthcare, Government and Research. To achieve this objective and to ensure successful careers with the MS degree or successfully pursue doctoral degrees, the graduates must acquire the following abilities:

- To successfully apply analytical methods (especially probability and statistics) to biomedical engineering problems.
- To successfully apply engineering methods, including modeling, simulation and design to biomedical problems.
- To communicate in clear and concise technical language and to effectively present their research or design results.
- To understand the basic concepts, tools and methodology of research. This will help them in successfully pursuing doctoral studies.

The inputs from outcomes assessment processes and the feedback loop necessary to ensure the continuous improvement of the degree to which these outcomes will be achieved are depicted in Figure 3. The assessment plan is very similar to the one successfully used for the PhD in Engineering Science which is also interdisciplinary in nature and is also being administered by the Dean's Office. With reference to figure 3, the outcomes assessment tools to be used are as follows:

- Evaluation of the thesis or capstone report by the student's committee, in terms of content, originality, quality of design and presentation.

Master of Science & Master of Engineering

Biomedical Engineering

Organizational Structure for Program Monitoring
Outcomes Assessment and Decision Making Process

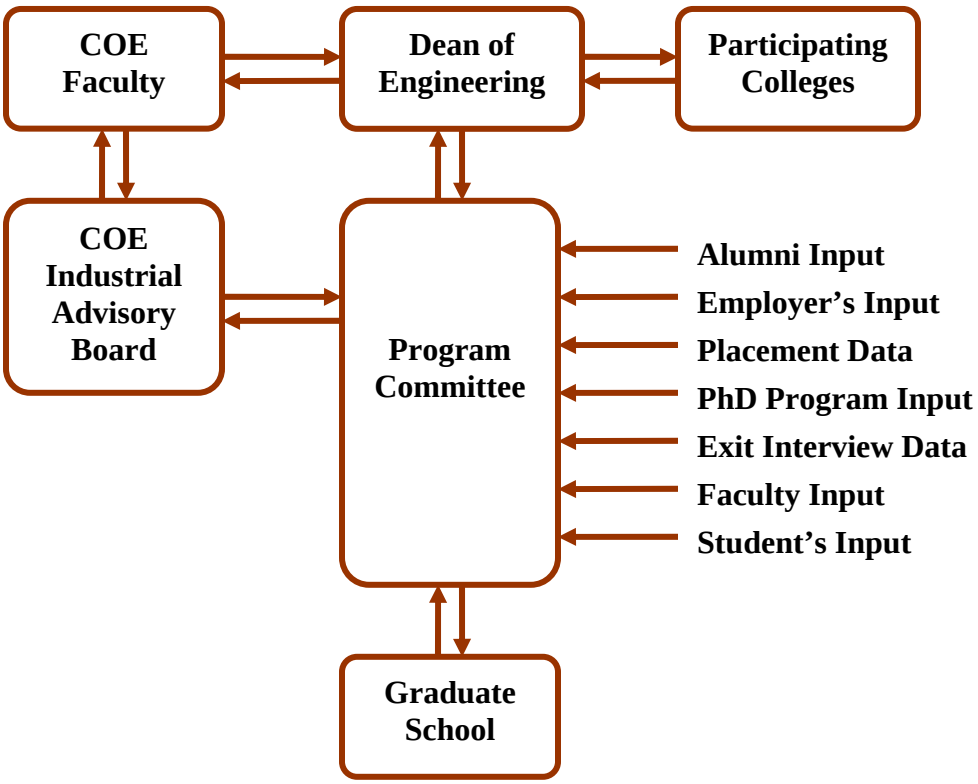


Figure 3. Outcome Assessment Plan and Decision Making Process

- Evaluation of the overall training of the student through the thesis defense and oral comprehensive examination.

- Input from the exit interviews, designed to evaluate the degree of achievement of the program outcomes. From the exit interviews data regarding number of interviews, number of job offers and salaries offered will be obtained and analyzed.

- Input from individual course assessments, including evaluation of the knowledge of the fundamentals by the student body.

- Input from alumni one and two years after graduation.

- Input from employers regarding strengths, weaknesses and career advancement information of the program graduates.

- Input from doctoral programs, which would offer positions to our graduates, including our doctoral program in Engineering Science.

- Peer reviewed technical publications, both before and after the award of the degree, constitute an excellent tool for outcomes' assessment. Finally, the employment data and the professional success of the graduates, which will be monitored closely, will be the best outcomes' assessment tools, and will provide the most conclusive input for the continuing improvement of the program.

13.2. Closing the Feedback Loop

All the data obtained from the outcomes assessment processes will be analyzed, on an annual basis, by the Program Coordinator and the Program Committee. The units to be involved in the process of evaluating this report include the College of Engineering Industrial Advisory Board and the colleges and departments participating in the program. Taking into account the opinions of all the units involved, the Program Committee will, annually, make their recommendations to the Faculty of the College of Engineering regarding the actions to be taken to continuously improve the program. The flow of information to achieve the decision making process is depicted in figure 3.

Appendix I

Biomedical Engineering

Areas of Concentration

Lists of BME Courses and BME-Related Courses

Biomedical Engineering Concentrations

Bioinformatics & Computational Medicine

Course Number	Course Title
BME 531	Optical Diagnostic and Monitoring Principles
BME 532	Biomedical Image Analysis and Spectroscopy
BME 535	Information Processing in Biomedical Engineering
BME 537	Embedded Microprocessor System Design
ECE 542	Optical Information Processing
ECE 551	Probability and Stochastic Processes for Engineers
ECE 555	Information Theory
ECE 568	Pattern Classification
ECE 572	Neural Networks
ME 565	Finite Element Analysis
ME 577	Bioprocess Engineering
PSYC 514	Neurobiological Bases of Behavior
PSYC 516	Human Clinical Neuroanatomy
PHYS 531	Advanced Quantum Mechanics
PHYS 550	Computational Physics
PSAS 571	Genomics of Eukaryotes
MBMB 556	Computer Techniques in Systematic Biology
MBMB 562	Molecular Genetics

Modeling and Simulation of Biomedical Processes

Course Number	Course Title
BME 536	Modeling and Synthesis of Biological Mechanisms
BME 537	Embedded Microprocessor System Design
BME 538	Medical Instrumentation: Application and Design
BME 541	Diagnostic Ultrasound Physics

ECE 523	Low Power VLSI Design
ECE 528	Advanced Computer Architecture
ECE 563	Estimation Theory
ECE 584	Linear and Non-Linear Networks
CS 501	Advanced Computer Architecture
PLB 524	Advanced Plant Genetics
PSAS 571	Genomics of Eukaryotes
MBMB 520	Advanced Microbial Physiology and Control Mechanisms
MBMB 530	Advanced Cellular Biology
MBMB 531	Molecular and Cellular Biology
PHYS 550	Computational Physics
ZOOL 573	Physiological Ecology
PSYC 514	Neurobiological Bases of Behavior
PSYC 516	Human Clinical Neuroanatomy
ME 565	Finite Element Analysis
ME 577	Bioprocess Engineering
Biomedical Imaging	
Course Number	**Course Title**
BME 531	Optical Diagnostic and Monitoring Principles
BME 532	Biomedical Image Analysis and Spectroscopy
BME 533	Speech Processing
BME 534	Sensors/Measurements
ECE 542	Optical Information Processing
ECE 558	Digital Image Processing I
ECE 568	Pattern Classification
ECE 574	Non-Linear Optics
ECE 578	Digital Image Processing II
ME 504	X-Ray Diffraction and Electron Microscopy
CHEM 536	Principles of Mass Spectrometry
CHEM 537	Fluorescence Spectroscopy

SPCM 501	Introduction to Speech Communication Research
CDS 519	Medical Speech-Language Pathology and Augmentative Communication
Biomedical Instrumentation	
Course Number	**Course Title**
BME 533	Speech Processing
BME 534	Sensors/Measurements
BME 535	Information Processing in Biomedical Engineering
BME 537	Embedded Microprocessor System Design
BME 538	Medical Instrumentation: Application and Design
BME 541	Diagnostic Ultrasound Physics
ECE 523	Low Power VLSI Design
ECE 528	Advanced Computer Architecture
ECE 564	Optimal Control
ECE 565	Nonlinear Systems Analysis
ECE 566	Adaptive Control
ECE 574	Nonlinear Optics
ME 545	Intelligent Control
ME 565	Finite Element Analysis
ENGR 530	Engineering Data-Acquisition
ENGR 540	Design of Engineering Experiments
CS 501	Advanced Computer Architecture
SPCM 501	Introduction to Speech Communication Research
CDS 519	Medical Speech-Language Pathology and Augmentative Communication
Biomechanics and Biomaterials	
Course Number	**Course Title**
BME 535	Information processing in Biomedical Engineering
BME 539	Biomechanics I
BME 540	Biomechanics II- Artificial Organs
BME 541	Diagnostic Ultrasound Physics

BME 542	Biomaterials-stem cell engineering
ME 504	X-Ray Diffraction and Electron Microscopy
ME 509	Thermal Radiation Heat Transfer
ME 531	Reaction Engineering and Rate Processes
ME 538	Applied Optimal Design and Control of Dynamic Systems
ME 553	Materials Processing
ME 562	Environmental Degradation of Materials
ME 564	Ceramic Materials in Electronics
ME 565	Finite Element Analysis
ME 566	Advanced Mechanics of Materials
ME 577	Bioprocess Engineering
ENGR 530	Engineering Data-Acquisition
ENGR 540	Design of Engineering Experiments
PE/KIN 505	Biomechanical Factors in Movement
PSYC 514	Neurobiological Bases of Behavior
PSYC 516	Human Clinical Neuroanatomy

Appendix II

Biomedical Engineering

Existing Courses Offered by Different Units on Campus

(BME-Related Courses)

Biomedical Engineering Program

Existing BME-Related Courses

Descriptions of Existing Courses are Available in the Online Graduate Catalog:

http://www.siu.edu/gradschl/catalog.htm

Course Number	Course Title
Communication Disorders & Science	
CDS 519	Medical Speech-Language Pathology and Augmentative Communication
Chemistry and Biochemistry	
CHEM 536	Principles of Mass Spectrometry
CHEM 537	Fluorescence Spectroscopy
Computer Science	
CS 501	Advanced Computer Architecture
Electrical and Computer Engineering	
ECE 523	Low Power VLSI Design
ECE 528	Advanced Computer Architecture
ECE 542	Optical Information Processing
ECE 551	Probability and Stochastic Processes for Engineers

ECE 555	Information Theory
ECE 558	Digital Image Processing I
ECE 563	Estimation Theory
ECE 564	Optimal Control
ECE 565	Nonlinear Systems Analysis
ECE 566	Adaptive Control
ECE 568	Pattern Classification
ECE 572	Neural Networks
ECE 574	Non-Linear Optics
ECE 578	Digital Image Processing II
ECE 584	Linear and Non-Linear Networks
Engineering	
ENGR 530	Engineering Data-Acquisition
ENGR 540	Design of Engineering Experiments
Molecular Biology, Microbiology & Biochemistry	
MBMB 520	Advanced Microbial Physiology and Control Mechanisms
MBMB 530	Advanced Cellular Biology
MBMB 531	Molecular and Cellular Biology
MBMB 556	Computer Techniques in Systematic Biology
MBMB 562	Molecular Genetics
Mechanical Engineering	
ME 504	X-Ray Diffraction and Electron Microscopy
ME 509	Thermal Radiation Heat Transfer
ME 531	Reaction Engineering and Rate Processes
ME 538	Applied Optimal Design and Control of Dynamic Systems
ME 545	Intelligent Control

ME 553	Materials Processing
ME 562	Environmental Degradation of Materials
ME 564	Ceramic Materials in Electronics
ME 565	Finite Element Analysis
ME 566	Advanced Mechanics of Materials
ME 577	Bioprocess Engineering
Physical Education	
PE/KIN 505	Biomechanical Factors in Movement
Physics	
PHYS 531	Advanced Quantum Mechanics
PHYS 550	Computational Physics
Plant Biology	
PLB 524	Advanced Plant Genetics
Plant and Soil Science	
PSAS 571	Genomics of Eukaryotes
Psychology	
PSYC 514	Neurobiological Bases of Behavior
PSYC 516	Human Clinical Neuroanatomy
Speech Communication	
SPCM 501	Introduction to Speech Communication Research

Zoology	
ZOOL 573	Physiological Ecology

Appendix III

Biomedical Engineering

List and Descriptions of New BME Courses

Biomedical Engineering Program

List of New Courses (BME)

Course Number	Course Title
BME 501	Statistics for Biomedical Engineers
BME 531	Optical Diagnostic and Monitoring Principles
BME 532	Biomedical Image Analysis and Spectroscopy
BME 533	Speech Processing
BME 534	Biomedical Sensors & Measurements
BME 535	Information Processing in Biomedical Engineering
BME 536	Modeling and Synthesis of Biological Mechanisms
BME 537	Embedded Microprocessor System Design
BME 538	Medical Instrumentation: Application and Design
BME 539	Biomechanics I
BME 540	Biomechanics II
BME 541	Diagnostic Ultrasound Physics
BME 542	Biomaterials-Stem Cell Engineering
BME 592	Biomedical Capstone Design
BME 593	Advanced Topics in Biomedical Engineering
BME 597	Biomedical Research Ethics
BME 598	Biomedical Seminar
BME 599	Thesis
BME 601	Continuing Enrolment

BME 501	Statistics for Biomedical Engineers
Catalog Data	Theoretical introduction to the basic principles of statistical modeling and estimation focusing on biomedical engineering applications such as genetics and genetic-related disorders.

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-
Prerequisites:	PHSL 410A or consent of instructor						
Course Coordinator:	BME Faculty						

Textbooks

1. Statistical Methods for the Analysis of Biomedical Data, 2nd Edition by Robert F. Woolson, and William R. Clarke, 2002.

References

1. Robust Statistics (Wiley Series in Probability and Statistics) by Peter J. Huber, 2003.
2. Introduction to Applied Statistical Signal Analysis, Third Edition: Guide to Biomedical and Electrical Engineering Applications (Biomedical Engineering) by Richard Shiavi, 2006.

Goals	Familiarize the students with the theoretical and experimental concepts of statistical modeling and analysis

Projects

Major CAD Packages

Last Review:		Signature:	

BME 531	Optical Diagnostic and Monitoring Principles
Catalog Data	Working knowledge of the theoretical and experimental principles of optically based monitoring and diagnostic systems; emphasis on generating quantitative descriptions of biochemical and biophysical interactions of optic and fiber optic systems as applied to medical diagnostics and sensing.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	ECE 441 or consent of instructor						
Course Coordinator:	BME Faculty						

Textbooks

1. Handbook of Optical Biomedical Diagnostics by Valery V. Tuchin, 2002.

References

1. Intermediate Optical Design by Michael J. Kidger, 2004.
2. Near-Field Nano-Optics: From Basic Principles to Nano-Fabrication and Nano-Photonics (Lasers, Photonics, and Electro-Optics) by Motoichi Ohtsu et al., 1999.

Goals	Familiarize the students with the theoretical and experimental concepts of optical diagnostic systems

Projects

Major CAD Packages

Last Review:		**Signature:**	

BME 532	Biomedical Image Analysis and Spectroscopy
Catalog Data	This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the major medical imaging systems including CT, MRI, Ultrasound, and X-ray. Application of optical spectroscopy (absorption, fluorescence and scattering) in biomedical engineering is also included.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Consent of instructor						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. Biomedical Image Analysis (Biomedical Engineering) by Rangaraj M. Rangayyan, 2004

References

1. Biomedical Applications of Spectroscopy by R. J. H. Clark (Editor), R. E. Hester, 1996.

Goals	1. Familiarize the students with the basic principles of design and operation of major medical imaging systems.

Projects

Major CAD Packages

Last Review:		**Signature:**	

BME 533	Speech Processing
Catalog Data	Fundamentals of speech production system, signal analysis of speech, speech coding, linear prediction analysis, speech synthesizing, and speech recognition algorithms.

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-
Prerequisites:	ECE 468 or consent of instructor.						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition by Daniel Jurafsky and James H. Martin, 2001

References

1. Discrete-Time Speech Signal Processing: Principles and Practice by Thomas F. Quatieri, 2001

Goals	1. To familiarize the students with the mechanism of speech production 2. To analyze the speech signal 3. To understand the speech recognition algorithms

Projects

Major CAD Packages

Last Review:		Signature:	

BME 534	Biomedical Sensors & Measurements

Catalog Data	Design and evaluation of sensors for applications in biomedical engineering. Instrumentation and techniques for measurements related to biomedical applications. .

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-

Prerequisites:	PHSL 410A, CHEM 444, or consent of instructor
Course Coordinator:	Biomedical Engineering Faculty

Textbooks

1. Sensors and Sensing in Biology and Engineering by Friedrich G. Barth , Joseph A.C. Humphrey , and Timothy W. Secomb, 2004

References

1. The Measurement, Instrumentation and Sensors Handbook, by John G. Webster, 1998.
2. Sensor Technology Handbook by Jon S Wilson, 2004.

Goals	1. To design a sensor for a specific biomedical engineering application. 2. To understand how to select and evaluate a sensor for a specific biomedical engineering applications.

Projects

Major CAD Packages

Last Review:		Signature:	

BME 535	Information Processing in Biomedical Engineering

Catalog Data	Methods for evaluating alternative approaches in signal processing systems for biomedical applications; provides familiarity with the variety of exciting software and hardware systems.

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-

Prerequisites:	PHSL 410A or consent of instructor.
Course Coordinator:	Biomedical Engineering Faculty

Textbooks

1. Biomedical Signal Analysis: A Case-Study Approach by Rangaraj M. Rangayyan, 2001.

References

1. Biomedical Signal Processing and Signal Modeling by Eugene N. Bruce, 2000.
2. Elements of Information Theory by T.M. Cover and J.A. Thomas, 1991.

Goals	1. To familiarize the students with the tools and techniques for extracting and processing information from biomedical-related signals

Projects

Major CAD Packages

Last Review:		Signature:	

BME 536	Modeling and Synthesis of Biological Mechanisms
Catalog Data	Mathematical and computer modeling of physiological systems and mechanisms; principal emphasis on cardiovascular system, nerve cells, respiratory system, renal system, and skeletal-muscle system; extensive use of "hands-on" computer modeling using HDL.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**0**
Prerequisites:	PHSL 410, or CHEM 444, and ECE421, or consent of instructor						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. *HDL Programming Fundamentals by N. Botros, 2005*
2. *Medical Physiology by* Boron and Boulpaep, 2005.

References

1. Molecular Cell Biology by Lodish, et al., 5th Edition, 2003
2. Advanced Organic Chemistry by Jerry March, 2004.

Goals	1. To familiarize the students with the basic knowledge of modeling biological mechanisms. 2. To familiarize the students with the state-of-art computer aided design tools for simulation and synthesis.

Projects

1. Modeling and realization of a compressive biological mechanism

Major CAD Packages

1. Xilinx CAD Package

Last Review:		**Signature:**	

BME 537	Embedded Microprocessor System Design
Catalog Data	Design, analysis, and evaluation of microprocessor-based systems for biomedical implementation.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	ECE 424 or consent of instructor						
Course Coordinator:	BME Faculty						

Textbooks

1. Computers as Components: Principles of Embedded Computer Systems Design by Wayne Wolf, 2000.

References

1. Embedded Systems Design, Second Edition by Steve Heath, 2002.
2. Embedded Linux System Design and Development by P. Raghavan et al., 2005.

Goals	1. To understand the technology of embedded systems. 2. To design and evaluate a biomedical-based embedded microprocessor system. .

Projects

1. Design of a moderately-complex embedded microprocessor system.

Major CAD Packages

Last Review:		**Signature:**	

BME 538	Medical Instrumentation: Application and Design
Catalog Data	Basic concept of Medical instrumentation, basic sensors and principles, amplifiers, biopotential electrodes, blood pressure and sound, measurement of respiratory system, chemical biosensors, Cellular measurements, Nervous system measurements, magnetic resonance imaging .

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	PHSL 410A or CHEM444, and ECE345 or consent of instructor						
Course Coordinator:	BME Faculty						

Textbooks

1. "*Bioinstrumentation*", John G. Webster, ISBN: 0-471-26327-3, Wiley publisher, August 2003

References

1. "*Medical instrumentation: application and design*" / John G. Webster, editor; contributing authors, John W. Clark. Wiley publisher August 1997.
2. *"Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices"* by David Prutchi, and Michael Norris Wiley-Interscience, November 22, 2004.

.

Goals	1. To design basic medical instrumentation. 2. Function and operation of complex medical instrumentation. .

Projects

2. Design of a moderately-complex medical instrumentation such as measurement and analysis of brain waves.

Major CAD Packages

1. Xilinx CAD tools

Last Review:		**Signature:**	

BME 539	Biomechanics I
Catalog Data	Introduction to mechanical behavior of biological tissues and systems, influence of material properties on the structure and function of organisms, methods for the analysis of both rigid body and deformational mechanics with application to include biological tissues such as bone, muscle, and connective tissues.

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-
Prerequisites:	ME 470 or consent of instructor						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation by Nihat Özkaya et al., 1999.

References

1. Biomechanical Basis of Human Movement by Joseph Hamill, and Kathleen M. Knutzen, 2003.

Goals	To familiarize the students with the mechanical behavior of biological tissues and systems.

Projects

Major CAD Packages

Last Review:		Signature:	

BME 540	Biomechanics II
Catalog Data	Advanced topics in Biomechanics focusing on design, development and evaluation of artificial organs.
-	

Course Total Credit Hours:	3	Lecture:	3	Laboratory:	-	Project	-

Prerequisites:	ME 470 or consent of instructor.
Course Coordinator:	Biomedical Engineering Faculty

Textbooks

1. Tissue Engineering and Artificial Organs by Joseph D. Bronzino, 2006.

References

1. Bioartificial Organs: Science, Medicine, and Technology (Annals of the New York Academy of Sciences) by Ales Prokop (Editor), et al., 1997.

Goals	1. Introduce cutting-edge information from this rapidly expanding field. 2. Familiarize the students with transport phenomena, and tissue and rehabilitation engineering.

Projects

Major CAD Packages

Last Review:		Signature:	

BME 541	Diagnostic Ultrasound Physics
Catalog Data	Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Modern physics, calculus & Fourier analysis or consent of instructor.						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. Diagnostic Ultrasound Imaging: Inside Out by Thomas Szabo, 2004

References

1. Essentials of Ultrasound Physics by James A. Zagzebski, 1996
2. Diagnostic Ultrasound: Physics and Equipment by Peter Hoskins et al. 2002

Goals	To familiarize the students with the essential science and signal processing principles of diagnostic ultrasound including scattering, propagation, and imaging.

Projects

Major CAD Packages

Last Review:		**Signature:**	

BME 542	Biomaterials
Catalog Data	This course addresses the bulk and surface properties of biomaterials used for medical implants, range of materials currently being utilized for various biomedical applications, the biological systems governing biomaterial applications, analytical techniques pertinent to biomaterial evaluation, and selected major medical applications in which biomaterials play an important role.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	ME 410 or consent of instructor						
Course Coordinator:	Biomedical Engineering Faculty						

Textbooks

1. Biomaterials Science, Second Edition: An Introduction to Materials in Medicine by Buddy D. Ratner et al., 2004.

References

1. Transport Phenomena in Biological Systems by George A. Truskey et al., 2003.
2. An Introduction to Tissue-Biomaterial Interactions by Kay C. Dee et al., 2002.

Goals	1. Understand the effect of bulk and surface properties of materials used for medical implants. 2. Understand the mechanics of tissue-biomaterial interaction.

Projects

Major CAD Packages

Last Review:		**Signature:**	

BME 592	Biomedical Capstone Design
Catalog Data	Individual advanced project, with heavy emphasis on design, selected by the student and approved by his advisor. The project must be strongly related to biomedical engineering. This project normally will be equivalent to three credit hours. However with the approval of the BME program coordinator, the project could be equivalent to a maximum of six credit hours.

Course Total Credit Hours:	**3-6**	**Lecture:**	**-**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Consent of instructor						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals			
Last Review:		**Signature:**	

BME 593	Advanced Topics in Biomedical Engineering
Catalog Data	Lectures on advanced topics of special interest to students in various areas of biomedical engineering. This course number is used to test new experimental courses in Biomedical Engineering.

Course Total Credit Hours:	**3**	**Lecture:**	**3**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Consent of instructor						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals	

Last Review:		**Signature:**	

BME 597	Biomedical Research Ethics
Catalog Data	Series of lectures from distinguished speakers, from academia, industry and government, regarding ethical issues associated with biomedical research and development. Graded S/U or DEF only.

Course Total Credit Hours:	**1**	**Lecture:**	**1**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Enrollment in the BME program						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals	

Last Review:		**Signature:**	

BME 598	Biomedical Seminar
Catalog Data	Must be taken in two semesters, one credit hour per semester. The first hour must be taken during the student's first semester of study. The intent is to provide an introduction to biomedical engineering through a series of lectures from speakers, from academia, industry and government, regarding biomedical engineering. The second hour will be the traditional graduate seminar for the biomedical engineering program. Graded S/U or DEF only.

Course Total Credit Hours:	**2**	**Lecture:**	**2**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Enrollment in the BME program						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals	

Last Review:		**Signature:**	

BME 599	Thesis
Catalog Data	Students are eligible to register for thesis when they have completed Module 1 of the BME program and the approval of the instructor who will act as thesis advisor.

Course Total Credit Hours:	1-6	Lecture:	-	Laboratory:	-	Project	-
Prerequisites:	Completion of Module 1 coursework and consent of instructor						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals	

Last Review:		Signature:	

BME 601	Continuing Enrollment
Catalog Data	For those graduate students who have not finished their degree programs and who are in the process of their thesis or capstone design course. The student must have completed all other course requirements to be eligible to register in this course. Concurrent enrollment in any other course is not permitted. Grated S/U or DEF only.

Course Total Credit Hours:	**1**	**Lecture:**	**-**	**Laboratory:**	**-**	**Project**	**-**
Prerequisites:	Completion of all coursework except BME 592 or BME 599						
Course Coordinator:	BME Program Coordinator						

Textbooks

References

Goals	

Last Review:		**Signature:**	

Appendix IV

Biomedical Engineering

Letters of Support

J. Kevin Dorsey	Dean and Provost, School of Medicine
Gary L. Minish	Dean, College of Agricultural Sciences
Richard W. Steger	Chair, Department of Physiology
Aldo D. Migone	Chair, Department of Physics
Thomas J. Firestone	President and CEO SIH
David A. Lightfoot	Professor of Genetics and Biochemistry
Lori Vermeulen	Chair, Department of Chemistry and Biochemistry
Jane L. Swanson	Chair, Department of Psychology
Randel Frazier	Vice-president for R&D Tyco Mallinckrodt Imaging
Jack Parker	Dean, College of Science
David Carlson	Dean, Library Affairs

Southern
Illinois University
School of Medicine

July 20, 2006

William P. Osborne, Ph.D.
Office of the Dean
College of Engineering
MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901-6603

Dear Dr. Osborne:

As you know from the discussions that we have had, I am strongly in support of your proposal for a Master of Science degree in Biomedical Engineering. I have reviewed your draft proposal and feel that it meets all of the requirements for a quality program. I am aware that there is both a significant desire on the part of students for such a program and a need for biomedical engineers as well. I anticipate that such a program could strengthen both your college and mine by having such an offering. Without it, I am certain we are losing very well qualified applicants to both engineering and medicine. Moreover, I agree that the greatest benefit of such a program is likely to be the fostering of collaborative research between multiple colleges and schools. As you know, the National Institutes of Health is clearly moving in the direction of collaborative team research and this should only enhance our ability to secure federal funding in the future. I know that my faculty is eager to see the Masters in Biomedical Engineering program approved quickly.

If I can do anything else to support this effort, please do not hesitate to let me know.

Sincerely,

Kevin

J. Kevin Dorsey, M.D., Ph.D.
Dean and Provost

RECEIVED
JUL 21 2006
COLLEGE OF
ENGINEERING

Office of the Dean and Provost
kdorsey@siumed.edu
Southern Illinois University School of Medicine
801 N. Rutledge St.
PO Box 19620
Springfield, Illinois 62794-9620
217 | 545-3625 Fax: 217 | 545-0786
www.siumed.edu

Southern
Illinois University
Carbondale

July 21, 2006

Dr. William P. Osborne
Dean
College of Engineering
Mail Code 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901

Dear Dr. Osborne:

On behalf of the College of Agricultural Sciences, we strongly endorse the new M.S. degree program in Biomedical Engineering. It is a great opportunity for faculty to collaborate in research and graduate training between the Colleges of Agricultural Sciences, Engineering, and Science and Southern Illinois University School of Medicine.

Specifically, the College of Agricultural Sciences would have faculty expertise and courses to offer in Biotechnology and Genomics, Animal and Microbial Physiology, and Agricultural Systems. Overall, the Biomedical M.S. degree program would broaden the scope of our graduate education programs, enhance student enrollment, and strengthen interdisciplinary research between colleges, schools, and disciplines.

Again, we strongly endorse the proposal for an M.S. degree program in Biomedical Engineering and look forward to being an active participant.

Sincerely,

Gary L. Minish
Dean

RECEIVED
JUL 25 2006
COLLEGE OF
ENGINEERING

College of Agricultural Sciences
www.siu.edu/departments/coagr/
Agriculture Building - Mail Code 4416
Southern Illinois University Carbondale
1205 Lincoln Drive
Carbondale, Illinois 62901
618 | 453.2469 Fax: 618 | 453.2505
www.siuc.edu

Southern Illinois University Carbondale

July 28, 2006

Dr. William P. Osborne
Office of the Dean
College of Engineering, MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901

Dear Dean Osborne:

I am pleased to write this letter in support of the proposal for a new MS in Biomedical Engineering. Our personal conversations over the last year, meetings with interested faculty from numerous departments throughout SIUC, and discussions within the Physiology Department have convinced me that this would be a very attractive program for students and would provide the type of training that would produce graduates in high demand by a number of industries. I was very pleased to see that you and your faculty were able to put together such a well-designed and well thought out proposal.

The Physiology Department looks forward to working with these students in a formal classroom setting, as well as in our research labs. The concept of a "Capstone Project" is especially exciting and I see a number of our faculty and students wanting to become involved in these interdisciplinary projects. I also see this program as enhancing the research efforts of our faculty, as it will bring new expertise in equipment design and data analysis to the Carbondale campus. Of equal importance is the entirely reasonable expectation that this program will help attract quality students and faculty to Carbondale.

Again, the Physiology Department looks forward to the establishment of the Biomedical Engineering MS and will be glad to assist you wherever possible.

Sincerely,

Richard W. Steger, Ph.D.
Professor and Chair

RWS:pj

Department of Physiology
School of Medicine
www.siumed.edu/physiology/
Mail Code 6512
Southern Illinois University Carbondale
1125 Lincoln Drive
Carbondale, Illinois 62901
618 | 453.1544 Fax: 618 | 453.1517
www.siu.edu

Southern Illinois University Carbondale

July 28, 2006

Dr. William P. Osborne, Dean
College of Engineering

Dear Dean Osborne:

This letter is to express my support on behalf of the Department of Physics, for the Master of Science in Biomedical Engineering, the new graduate program being proposed by the College of Engineering.

The area of Biomedical Engineering is one in which some faculty from my Department have an active interest. The proposed graduate program will help develop even further what have traditionally been very positive collaborative interactions in research and education between the members of your College and those from the Department of Physics.

As the MS in Biomedical Engineering develops I am sure we will be able to explore ways in which the Department of Physics can assist (for example, by developing courses that have your students as a primary focus).

From a wider perspective, any new program that enhances research at our institution, and helps raise our institutional profile, is a development has to be greeted by all as a welcome addition.

Wishing you much success in this undertaking,

Aldo Migone

Aldo D. Migone
Professor and Chair
Department of Physics

Department of Physics
Neckers 483- Mail Code 4401
Southern Illinois University Carbondale
1245 Lincoln Drive
Carbondale, Illinois 62901
Tel: 618-453-2643 Fax: 618-453-1056
http://www.physics.siu.edu

SOUTHERN ILLINOIS HEALTHCARE

University Mall
1239 East Main Street
PO Box 3988
Carbondale, Illinois
62902-3988

TEL 618.457.5200
EXT 67030
FAX 618.529.0568
EMAIL tom.firestone@sih.net

www.sih.net

July 18, 2006

William P. Osborne
Office of the Dean
College of Engineering
MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, Illinois 62901

Re: MS in Biomedical Engineering

Dear Dean Osborne:

I have reviewed your draft proposal for developing a graduate degree program in biomedical engineering at Southern Illinois University Carbondale. It appears to me that you have carefully evaluated the need for such a program and have designed the curriculum to adequately prepare graduates for the biomedical engineering field.

As you have clearly articulated in your proposal, there is definitely growth potential in this exciting field. The healthcare industry embraces technology and requires highly educated and skilled professionals to deliver care to patients. Biomedical engineering is an important part of the care delivery process, and advancements in this field will be an important part in maintaining our quality of life.

You are to be commended for your visionary leadership in developing this program. I am happy to write this letter of support for this program, and know that you can achieve success. I wish you success!

If I can be of any help in making this initiative successful, please contact me.

Sincerely,

T.J. Firestone MD

Thomas J. Firestone, M.D., FACEP
President and Chief Executive Officer

TJF/smr

Southern Illinois University Carbondale

August 25, 2006

William P. Osborne
Office of the Dean
College of Engineering
MC 6603
SIUC
1230 Lincoln Drive
Carbondale, IL 62901

Dear Dean Osborne:

This letter is to indicate the support of the Genomics Core Facility and associated laboratories to the new program request entitled "Master of Science Degree in Biomedical Engineering" for which you are PI. The interests of our group are complementary to your proposed objectives in that our group has a fundamental interest in plant derived nutraceuticals and the relative importance of different compounds to health outcomes. We have been particularly interested in the use of Biomedical Engineering in combination with diet in the field of nutrigenomics. Your proposed program to train students in Biomedical Engineering adds another dimension to these efforts that we had not considered. Your proposed use of facility is therefore greatly appreciated, as it will no doubt provide important information about the interaction of diet and health.

To assist you research we promise the full assistance of the Genomics Core Facility and the equipment infrastructure. Please feel free to include this infrastructure as part of your facilities statement for this proposal. Specific areas of expertise in our group that can be most helpful to your project include robotics, cell biology, protein analyses, and DNA analyses. We are expert in mRNA measurement in DD-, RT- and array- formats. We can therefore readily train students to identified biomarkers needed for cetain projects in Biomedical Engineering. All these tools and resources are at your disposal for this project as is the expertise of the technicians that support this equipment.

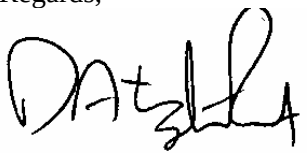
Regarding the training program you envision for both undergraduates and graduates. We include undergraduate and graduate researchers in all our projects and it is good to see your program will encourage this same approach. I concur that students who have received an interdisciplinary introduction to medically related topics in biology research are often better equipped as future medical professionals, scientists, teachers and policy makers. I have had significant contact with your current students, and I believe that they would benefit greatly from the new program. They are exceptional individuals who have been trained to carry out intricate experiments in other aspects of engineering. The growth of your College here at SIUC is certainly a credit to your talents. Your development of the new program request should allow your students access to an excellent MS program and should lead to increased emphasis on medical research by your College. I am sure that students and faculty involved in the program will generate unique and important discoveries. The results of your studies will have broad implications for both medical and agricultural

Southern Illinois University Carbondale

sciences. We at the Genomics Facility are confident the team you have assembled will accomplish the proposed objectives and look forward to assisting you in this endeavor.

Regards,

Regards,



Dr. David A. Lightfoot
Professor of Genetics & Biochemistry

Department of Plant Soil and General Agriculture, Mailcode 4415, Carbondale Illinois 62901-4415
Tel: 618/ 453 2496 Fax: 618/ 453 7457

Southern Illinois University Carbondale

Department of Chemistry and Biochemistry
1245 Lincoln Drive, Mail Code 4409
Carbondale, Illinois 62901
(618) 453-5721 FAX: (619) 453-6408
eMail: chemistry@chem.siu.edu
web: http://www.science.siu.edu/chemistry/

Lori A. Vermeulen
Associate Professor and Chair
(618) 453-6482
eMail: vermeulen@chem.siu.edu

August 22, 200

William P. Osborne
Office of the Dean
College of Engineering
MC 6603

Re: MS in Biomedical Engineering

Dear Dean Osborne,

I am pleased to extend my enthusiastic support for the development of a new MS in Biomedical Engineering. The program that you have proposed is timely and relevant to emerging new fields. The students at SIUC at both the graduate and the undergraduate levels will benefit tremendously from the availability of this program and the opportunities provided by it.

In the Department of Chemistry & Biochemistry, we have been building a core group of faculty with research interests that encompass materials chemistry and biological aspects of chemistry with projects ranging from the development of drug delivery and tissue engineering strategies to state-of-the art sensing technology that has the potential to be utilized in biological systems. This group of faculty will serve as a source of support for this new program. In addition, they will benefit from the new collaborative opportunities that the MS in Biomedical Engineering is certain to provide.

As you know, SIUC has a history of strength in materials research and in technology development. The Department of Chemistry & Biochemistry is proud to be an important part of that strong history and wishes to be included in the future vision that builds upon this strength. We therefore happily endorse your efforts and offer you our continued support.

Best Wishes,

Lori Vermeulen

Lori Vermeulen
Associate Professor and Chair

Southern
Illinois University
Carbondale

RECEIVED
AUG 24 2006
COLLEGE OF
ENGINEERING

August 22, 2006

William P. Osborne
Office of the Dean
College of Engineering
MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901

Dean Osborne,

The Department of Psychology is pleased to endorse the proposed MS degree program in Biomedical Engineering. We agree to support this degree program to the extent our departmental resources allow.

In particular, our courses PSYC 514 (Neurobiological Bases of Behavior) and PSYC 516 (Human Clinical Neuroanatomy) will serve as suggested courses for three of the five proposed concentrations. We will welcome qualified students enrolled in the MS program in these classes.

Please contact me if you need further information.

Sincerely,

Jane L. Swanson, Ph.D.
Professor and Chair

Department of Psychology
www.siu.edu/~psyc/
Mail Code 6502
Southern Illinois University Carbondale
1125 Lincoln Drive
Carbondale, Illinois 62901
618 | 536.2301 Fax: 618 | 453.3563
www.siuc.edu

tyco
Healthcare

Mallinckrodt

Mallinckrodt Inc.
675 McDonnell Boulevard
P.O. Box 5840
St. Louis, MO 63134

Tele: 314 654-2000
www.mallinckrodt.com

August 23, 2006

William P. Osborne
Office of the Dean
College of Engineering
MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901

Dear Dr. Osborne:

Thank you for the information you sent on the proposed MS in Biomedical Engineering program.

I strongly support the formation of such a program. In my career, I have employed and worked with several engineers that came from similar programs and found the multi-disciplinary approach presented in the program to have a significant positive impact on the graduates' abilities to address the unique needs in medical product development. The general concept of bringing together training from different schools, especially at the graduate level, lines up well with the way applied engineering is done in industry.

Thank you again for the information and good luck in getting the program started.

Sincerely,

Randel Frazier
Vice-President
Research and Development
Tyco Mallinckrodt Imaging

Southern Illinois University Carbondale

August 29, 2006

RECEIVED
AUG 29 2006
COLLEGE OF ENGINEERING

William P. Osborne
Office of the Dean
College of Engineering
MC 6603
Southern Illinois University Carbondale
1230 Lincoln Drive
Carbondale, IL 62901

Dear Dean Osborne:

I am very pleased to offer my support for the proposed new Master of Science degree in Biomedical Engineering. Faculty in several colleges, including the College of Science, carefully designed this program. I was pleased to be able to participate in some of the meetings that were held. This program will open up some genuinely interdisciplinary training opportunities for our students. It has my strong support.

Sincerely,

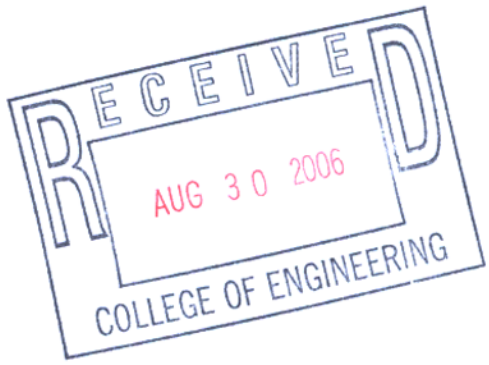
Jack Parker
Dean

JP/lsm

Office of the Dean, College of Science
Neckers A157 - Mail Code 4403
Southern Illinois University Carbondale
1245 Lincoln Drive
Carbondale, Illinois 62901
618 | 536.6666 Fax: 618 | 453.7067
www.siuc.edu

Southern Illinois University Carbondale

MEMORANDUM



August 28, 2006

To: William Osborne, Dean
College of Engineering

From: David Carlson, Dean
Library Affairs

Re: Library Resources for BME MS Program

I have reviewed the draft of your proposal for a Master of Science Degree in Biomedical Engineering. At your request, I have considered the implications of this proposal for the Library. I am pleased to report that this new program will be well supported with current resources available from the Library.

As you know, over the last several years the Library has emphasized the acquisition of resources in electronic full-text. This approach has enabled us to offer a significant collection of the full text of resources in referred, high-quality journals. For the BME program in particular, I would highlight our participation in IEEE's Xplore platform. IEEE "publishes the leading journals, transactions and magazines in electrical engineering, computing, biotechnology, telecommunications, power and energy, and dozens of other technologies." As of this morning, the indicator on the IEEE Xplore web site reported the availability of 1.4M documents available online through this platform.

Another critical resource for this program will be Elsevier's Science Direct platform. This database offers journals in the physical sciences and engineering, the life sciences (including biochemistry, genetics, and molecular biology) and the health sciences. Again, full text resources are available and as of this morning, this resource reports the online availability of approximately 7.8M articles.

In addition to these two critical resources, I would also mention the availability of the Annual Reviews database and Engineering Village II (Compendex). EV II is an index and abstracting database only, without full text, but this database does support our SFX citation linker tool. This tool will appear as a **Find It @ Morris** link in EV II citations. If used, this tool will lead any student or researcher from a citation or abstract in EV II to the full text (if available) in any of the other full text resources available through Library Affairs.

Library Affairs - Office of the Dean
www.lib.siu.edu
Morris Library - Mail Code 6632
Southern Illinois University Carbondale
605 Agriculture Drive
Carbondale, Illinois 62901
618 | 453.2522 Fax: 618 | 453.3440
www.siuc.edu

The databases I have listed are by no means a comprehensive inventory but these resources alone will provide a rich pool of information for students in this new program that is comprehensive in scope and high in quality.

If you need any additional information, please let me know.

Thank you.

DC:emw