ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Proposal to the Senate Educational Policy Committee

PROPOSAL TITLE: Establish a Major in Bioinstrumentation for the degree of Master of Engineering, College of Engineering

SPONSOR: Prof. Brian T. Cunningham, Director, Bioengineering Graduate Program. Faculty member in Department of Electrical and Computer Engineering and the Department of Bioengineering, 217-265-6291, bcunning@illinois.edu

COLLEGE CONTACT: William G. Butler, Associate Dean, Office of Graduate and Professional Education, College of Engineering, buttlar@illinos.edu

BRIEF DESCRIPTION: The Department of Bioengineering is proposing a major in Bioinstrumentation for the degree of Master of Engineering in the College of Engineering. The major in Bioinstrumentation will be a self-supporting program. A proposal for a differential tuition structure has been submitted to the Office of the Provost. The program is intended to be a 1-year professional master's program for industry-based engineering professionals who seek to develop their technical breadth and depth in fields related to biomedical imaging, life science research tools, disease diagnostic technology, DNA sequencing technology, and systems engineering. The curriculum is focused not only upon technical aspects of detecting/processing biological signals, but also upon methodology related to complex multidisciplinary engineering project management and project leadership. The program includes lectures and case studies from industry leaders and a capstone team project that is mentored by an industry advisor. Customization of the curriculum is provided through multiple technical tracks that enable students to focus their experience within their field of greatest interest. The curriculum requires 40 total credit hours and is comprised of:

- A "core" set of required courses for all students in the major (16 hours)
- A "track" set of courses selected from one of two areas of specialization (12 hours)
  - Track 1: Biomedical imaging
  - Track 2: Life science tools
- An elective course to satisfy the breadth requirement for all graduate programs (4 hours)
- A team-based major project (6 hours)
- A weekly seminar on Bioinstrumentation (2 hours)
- "Co-curricular" activities (not graded, or for credit) to enhance professional skills and to provide advance preparation for the program.

JUSTIFICATION:

Metrology, defined as the science of measurement, is applied across all the components of biological systems from molecules to entire animals. "Bioinstrumentation" can be defined to encompass a broad range of topics that include biomedical imaging modalities (ultrasound, MRI, CT, OCT), microscopy modalities (TIRF, confocal, SLIM, FTIR), biosensors (optical, acoustic, impedance, SERS), and molecular probes/tags (aptamers, FRET, quantum dots). Due to the scientific success in these fields, Bioinstrumentation-related technologies have been experiencing commercially important translation to industry. Bioinstrumentation currently underlies many of the most important developments that will impact our health, and are expected to continue to do so. Bioinstrumentation is central to all modes of biomedical imaging, point-of-care diagnostics, personalized medicine, high throughput genome sequencing, life science research, environmental monitoring, and biowarfare defense. As a result of this success, we anticipate a growing need for engineers who require deeper knowledge of Bioinstrumentation fundamentals in preparation for careers in industry, national laboratories, health policy, medical research, and medical practice. The M.Eng. in Bioinstrumentation is designed to serve students who seek these types of careers, but who are not interested in pursuing research. The Bioinstrumentation program is designed to provide more in-depth understanding of the underlying physical principles of biological detection, data/image/signal processing methods, molecular/cellular biology, bioinformatics, and instrumentation design than are available in an undergraduate curriculum. It is designed principally for students who wish to enter industry as practicing professionals.

Within industry, it is common for engineers and managers developing new tools for medical diagnostics, life science research, and imaging to work in a multidisciplinary team environment. Such an environment brings together engineers involved with detection instrumentation, signal processing, image processing, data analysis, and micro/nanofabrication who apply fundamental principles in acoustics, electromagnetics, material science, and computation. Development of such systems requires additional levels of interdisciplinary interaction, as they also involve physiology, cellular biology, molecular biology, and chemistry. It is difficult within the context of an undergraduate degree program to obtain the desired degree of depth within a focused area while obtaining sufficient breadth to collaborate effectively with colleagues from adjacent disciplines.

Discussions held with research managers and hiring managers of large bioinstrument-focused companies who regularly recruit from our campus have revealed some common needs that are addressed through the structure of this program. For example, when hiring at the master's level, companies primarily recruit students for their "hard core" fundamental engineering skills. For example, they desire students with a strong background in topics like signal filtering, signal processing, and amplification. In the area of medical imaging, students should have a strong fundamental knowledge of the physics behind the imaging modality and strong engineering knowledge of the hardware/software components of the system. However, typical engineers currently lack background knowledge about biology, physiology, disease, and medical practice that is relevant to their jobs, but which is currently learned only in the narrow context of a particular job assignment. Many engineers lack the "big picture," and thus may be limited in their ability to find creative solutions to some problems.

Industry managers have also expressed desire to see students gain experience through leading some type of project, and have indicated enthusiasm for serving as mentors for projects performed within the program. The problem should address a business/technical issue (like providing some technical capability or solving a technical problem that has real impact – not just a theoretical exercise). Projects should be organized so as to be a team experience requiring

coordination of members – as most projects are performed in industry. Interactions with industry through project mentorship provides companies with a way to evaluate potential hires that is more thorough than a short job interview. It also offers industry a chance to provide feedback to the program so that training of students can be targeted towards the needs of industry; a win-win scenario for both the students and industry.

Industry also desires new graduates with knowledge of business issues that are rarely discussed in the undergraduate curriculum. Topics like product life cycle, regulatory issues, operations, software validation (very important for software used in the medical field), EMI/UL testing, developing product requirements, performing risk analysis, tracing requirements to a design, six-sigma quality control, and design review are introduced in a new course entitled BIOE 573 Biomedical Systems Engineering. This course requires instructors with practical experience with these issues. Some topics will be taught by faculty from the business school, while others may be taught by industry guest lecturers.

The Bioinstrumentation major within the M.Eng. degree is designed to provide the workplace and students with the alternative of a professionally oriented degree that is accessible to students who either are funding their own education or whose financial support is derived through external corporate sponsorship. The program is designed to be completed in one calendar year for students who would reside on campus. The program is predominantly comprised of coursework with two suggested "tracks" which allow flexibility for students to customize their selections based upon individual interests. The tracks are: 1. Biomedical Imaging, and 2. Life Science Tools. The program will include a capstone design experience in which students will work in interdisciplinary teams that are jointly co-advised by a faculty member and an industry mentor. Initial focus areas include biosensors, biomedical imaging, pathology, cell imaging, and biomolecular imaging. A written report and presentation will be required for degree completion.

Market Assesssment

As Bioengineering becomes more established as a distinct academic discipline, several universities have established programs at the master's level to bridge the gap between undergraduate training and Ph.D.-level research training. Exemplary programs are described below – each with a slightly different focus in terms of targeted technology area, industry/academic/medical focus, time commitment, and research content. These programs are summarized in the following paragraphs. We are not aware of any existing comprehensive degree program that specifically focuses on the topic of Bioinstrumentation.

Many of the top programs currently offering master's degrees in Bioengineering have similarities. Many have significant funding and corporate partnerships that are affiliated with their programs. In addition, each has a close relationship or is affiliated with a medical school/hospital. Most programs charge tuition/fees in the $40K-50K range per year. Many advertise that they maintain an advisory committee consisting of leaders from academia and industry.

Duke offers an M.Eng. in Biomedical Engineering that can be completed in 3 semesters at a cost of $55,260. Students in the program receive personalized guidance from a faculty mentor and advisor. The program has developed relationships with biotech firms in the nearby research park (Siemens Medical Systems, Boehringer Mannheim, Genentech, Genetronics, Glaxo Wellcome, Guidant, and Medtronics), which in turn may provide unique opportunities for student internships. This program provides in-depth study in a technology field paired with business leadership and management education. The program specifically targets students with 2-5 years of industry experience. http://meng.pratt.duke.edu/biomedical

Boston University also offers an M.Eng. in Biomedical Engineering. This is a professional master's program for students who are focused on a career in industry, but not students who are already working in industry. The curriculum ensures that students looking for a career in the healthcare sector gain fundamental technology and commercialization skills important to biomedical engineers. Students in the M.Eng. degree program receive exposure to issues related to intellectual property and commercialization, and can select from existing biomedical engineering courses.

Wisconsin offers a Master of Engineering in Professional Practice (MEPP). The degree provides a blend of technical and management expertise that students can apply to their current position while preparing for engineering leadership roles. The program is advertised as a better investment than an MBA for most engineers. The 2-year program aims to improve students' ability to lead engineering projects and teams, to communicate effectively as a leader, and to make effective engineering and business decisions. This program is marketed to students with four or more years of experience wanting to move up the career ladder while staying involved in engineering. It is not specifically aimed at bioengineers.
http://mepp.engr.wisc.edu/Prospective_Students/Requirements_and_Fees.lasso

The University of California (UC)-Berkeley offers a master's degree in Bioengineering with coursework and project emphasis on translational medicine. The UC-Berkeley master's program links the schools of pharmacy and medicine at the UC-San Francisco with the College of Engineering at UC-Berkeley, and is designed to train students in applying translational research and engineering approaches to solve fundamental problems in healthcare delivery. The program is designed for engineers, scientists and clinicians who seek to bring innovative treatments and devices into clinical use. Students with backgrounds in medicine, nursing, dentistry, and pharmacy are the target demographic. Graduates work in industries that deliver healthcare products or patient care. Coursework includes material in the translational aspects of therapeutic science and the principles of engineering design. Content covers the fundamentals of bioengineering, physiology and disease processes, along with core medical principles, clinical research methods, clinical trials design, and some basics of business and management science. The program is completed in two semesters plus one summer.

The Department of Biomedical Engineering at Johns Hopkins University offers a Master of Science in Engineering program. Unlike the M.Eng. program proposed here, the JHU program is designed for students who wish to pursue careers in research and development, academics, or medicine. The 2-year program consists of 24 credits of course work and a thesis project. A two-semester course, Physiological Foundations in Biomedical Engineering, is required of all students. The remaining course requirements may be tailored to students' backgrounds and interests. The stated goal of the JHU program is to educate students in the interdisciplinary fields of engineering and medicine. Students in the master's program receive theoretical instruction in the traditional engineering disciplines, exposure to specialized topics in biomedical engineering, (such as biomedical instrumentation, systems physiology, biosensors, biomaterials, biomechanics, and biomedical imaging), and practical training in the form of supervised research projects. This program may be considered to be equivalent to earning an M.S. in Bioengineering at UIUC. John Hopkins offers an Engineering for Professionals program, which provides working engineers with relevant graduate-level education (masters or certificate is awarded). Students pay $3175 per course, with 10 courses required to earn a degree. http://ep.jhu.edu/

Penn State Engineering offers a Bioengineering M.S. program. Bioengineering master's degree candidates select either the thesis or non-thesis degree track during their first year. Students

typically complete their degree program in 12-18 months. The program provides an interdisciplinary education in scientific and engineering fundamentals, with an emphasis on new developments in the field of Bioengineering. The primary goal of the Penn Bioengineering master's program is to provide students with a customized curriculum designed to prepare them to function creatively and independently in industry, research and development, government or academia. The master's degree program provides training in engineering with a focus on biological and medical sciences. The curriculum allows students to select their own graduate coursework in math, biomedical sciences, bioengineering, and other science and engineering disciplines by taking courses in the Schools of Engineering, Arts and Sciences, and Medicine. The M.S. in Bioengineering is a "terminal degree," meaning that students interested in pursuing a Ph.D. must apply to the program through the Ph.D. graduate admissions process.

The Georgia Tech Master of Biomedical Innovation and Development (BioID) offers biomedical technology professionals a 1-year focused program. Graduates receive a "Master of Biomedical Innovation and Development" degree from The Georgia Institute of Technology. The program seeks to address a gap in current professional biomedical education: the "bench-to-bedside" progression that transforms biomedical research into practical, usable techniques and products for improving patient care. Georgia Tech BioID graduate students will be instructed by experts in clinical practice, engineering design and development, best-practices manufacturing, financial planning, and commercialization, as well as guest lecturers from the healthcare industry. This program accepted its first applicants for the Fall 2013 semester, and is possibly the program most closely related to our proposed program.

The Chemical and Biological Engineering Department at Northwestern offers a Biotechnology Training Program, which is aimed at Ph.D. students with thesis advisors. This is an interdisciplinary and interdepartmental program that promotes education in biotechnology, interactions among faculty and students with interests in biotechnology, and provides a substantial exposure of students to industrial biotechnology research. Students trained through this program are prepared to enter the biotechnology industry or pursue academic and governmental biotechnology research. The program involves internships at partner companies, special seminars, and lab rotations.
http://www.bme.northwestern.edu/graduate/special%20programs/index.html

Program Description

Study of competing master's-level programs in Bioengineering has identified key issues that need to be addressed for the M.Eng. in Bioinstrumentation to provide a unique program with strong competitive advantages. These are: a curriculum characterized by a set of highly integrated learning experiences designed to develop a student's essential knowledge and leadership skills, continuous program assessment, financial incentives for students, an Industry Advisory Board, an Industry Coordinator, and enhanced career services. Each of these are discussed below:

The proposed program curriculum is professionally oriented and aimed at providing students with greater depth and breadth for careers that involve the science of measuring physiological biological structures (tissues, organs), small biological units (cells, bacteria, viruses), and biological molecules (proteins, peptides, DNA). The designated home unit for the program is the Bioengineering Department. Due to the multidisciplinary nature of the topic, the program will involve the Department of Bioengineering (BIOE), Department of Electrical and Computer Engineering (ECE), the Department of Physics, the School of Molecular and Cellular Biology, Department of Chemistry, and the Department of Chemical Engineering. Admissions, advising,

and course/degree requirements will be administered by a director representing a program committee from the Departments involved in the Major.

The proposed curriculum is comprised of:

- A "core" set of required courses for all students in the major. New courses are proposed to fulfill this requirement: BIOE 571, BIOE 572, BIOE 573, and BIOE 574. Course descriptions are summarized in Appendix E.
- A "track" set of courses selected from one of two areas of specialization
    - Track 1: Biomedical imaging
    - Track 2: Life science tools
- An elective course (to satisfy the breadth requirement for all graduate programs)
    - Students with a primary background in engineering may choose a biology-based course. Students with a job-focused need to develop skills in a particular area may choose a desired engineering course.
- A team-based major project, BIOE 575.
- A weekly seminar on Bioinstrumentation, BIOE 570
- "Co-curricular" activities (not graded, or for credit) to enhance professional skills and to provide advance preparation for the program. A 5-day "boot camp" will be held prior to the start of the Fall semester. Additional activities will take place throughout the Fall and Spring semesters.

The foundation "core" curriculum will:

- Be a maximum of 16 hours in length
- Be program-centered and not discipline or department-centered
- Be taught by core teams responsible for identifying and integrating specific topics (called "modules") that avoid duplicative teaching of common concepts
- Integrate case studies drawn from actual industry examples
- Be subjected to continuous assessment of learning outcomes

The curriculum will introduce students to the core concepts inherent across many Bioinstrumentation fields (for example, DNA sequencing instruments, point-of-care diagnostics, ultrasound imaging, OCT, and MRI) but because the curriculum will be integrated, students will come to understand the relationships shared between these areas. Such an approach should encourage the application of concepts learned in one area to problems raised in another. The issue of how to achieve this integration is properly left to the experience and judgment of the core faculty.

The core faculty will have the following responsibilities for which their collaboration will be necessary:

- Design workloads (assignments, projects) and performance assessments (exams) that integrate the core topics.
- Establish the set of topics that will be presented in the core courses.
- To assess and update the modules within the curriculum as necessary to reflect changes in society, the workplace, technology, and engineering practice.

Faculty of the Program

The current Director is Prof. Brian Cunningham, as appointed by and reporting to the Head of the Department of Bioengineering. A number of current Illinois faculty members have expressed enthusiastic interest in serving as faculty of the M.Eng. program, and have participated in establishing the syllabus for BIOE 571 and 572. The initial group of participating faculty include:

Rohit Bhargava (BIOE)
Stephen Boppart (ECE and BIOE)
Brian Cunningham (ECE and BIOE)
Michael Insana (BIOE)
Sua Myong (BIOE)
Michael Oelze (ECE)
Gabriel Popescu (ECE)
Brad Sutton (BIOE)
Jian Ma (BIOE)

This list is not considered to be exhaustive or final.

To assure the desired level of integration, we recommend appointment of:

- A faculty member to serve as the "M.Eng. in Bioinstrumentation Core Coordinator" who will assist the core teaching teams in scheduling, topic sequencing, and similar activities.
- A standing committee within the Bioengineering Graduate Program called the "M.Eng. in Bioinstrumentation Curriculum Committee" comprised of the first and second-semester core faculty. This committee will be chaired by the Core Coordinator. The responsibility of this committee will be to coordinate the core teaching teams and the integration of topics.

The "track" set of courses are aimed at allowing students in the major to leverage the deep and broad existing expertise at the University of Illinois in the area of Bioinstrumentation, and to gain graduate-level knowledge in their specific field of interest. The "track" courses will:

- Be existing courses at the University of Illinois that are normally offered for graduate credit (400-level or 500-level) selected from a list of courses approved for use within the major.
- Exemplify the distinct research strengths of the Illinois faculty, and therefore serve as a foundation of the program's reputation.
- Serve the needs of industry in terms of producing graduates with technical depth required for job placement. The tracks should assist in attracting corporate support for employees who would take part in the program and subsequently return to their company.

The team-based major project is aimed at application of some of the principles learned during coursework. The projects will have the following characteristics:

- Will be performed and completed during the summer term.
- Will be performed by teams of no fewer than 3, but no more than 5 students.
- Teams will be assembled and assigned by the Core Coordinator, who will consider the needs of the project, the skills/experience of the students, and the balance of backgrounds required to address the problem effectively.

- Represent actual problems that are defined by industry, who will provide an engineer who agrees to serve as a consultant and project mentor.
- The project may be partially performed at an industry facility, or with materials/supplies provided by industry.
- Will culminate in a written report that describes the background of the problem, definition of milestones, alternative approaches considered, selection of an approach, engineering design/analysis, construction of hardware, development and validation of software, and analysis of whether the milestones had been achieved.
- The project will also culminate in an oral presentation to be made to the class, Industry mentors, and the core faculty. Each student must participate in delivering a section of the oral presentation.
- The industry mentor and the core faculty will evaluate the report and presentation for a grade, providing oral and written feedback.

The Bioinstrumentation Seminar will be held weekly for 1-hour per session during the fall and spring semesters. The purpose of the seminar is to demonstrate application of theoretical concepts from core courses, and to address business issues such as ethics, regulation, diversity, and globalization. The Core Coordinator will appoint a faculty member within the Curriculum Committee to coordinate the seminar speakers. Speakers may be Illinois faculty, visiting faculty from other campuses, industry leaders, and officials within government regulatory agencies. A budget will be provided from tuition funds to support travel costs and honoraria for guest speakers.

Based upon the above characteristics, the program is comprised of 40 hours organized as follows:

- BIOE 570 – Seminar in Bioinstrumentation (2 hrs)
- BIOE 571 –Biological Measurement I (4 hrs)
- BIOE 572 –Biological Measurement II (4 hrs)
- BIOE 573 – Biomedical Systems Engineering I (4 hrs)
- BIOE 574 –Bioinstrument Innovation (4 hrs)
- BIOE 575 – Bioinstrumentation Sys Project (6 hrs)
- Technical Track courses (12 hrs)
- Breadth Elective course (4 hrs)

All new courses have been reviewed and approved by the College of Engineering Executive Committee and by the Graduate College.

New Student Week
Bioinstrumentation Boot Camp

Fall Semester
BIOE 570 – Seminar in Bioinstrumentation (1 hr)
BIOE 571 –Biological Measurement I (4 hrs)
BIOE 573 – Biomedical Systems Engineering (4 hrs)
Course selected from track (4 hrs)
Free elective (4 hrs)

Spring Semester
BIOE 570 – Seminar in Bioinstrumentation (1 hr)
BIOE 572 –Biological Measurement II (4 hrs)
BIOE 574 – Bioinstrument Innovation (4 hrs)
Course selected from track (4 hrs)
Course selected from track (4 hrs)

Summer
BIOE 575 – Bioinstrumentation Project (6 hrs)

Continuous Program Assessment

At the outset of the program, we propose development of procedures to assess its effectiveness on an ongoing basis. Evaluations should focus on program objectives, curriculum content, services, instruction, student performance, graduate placement, industry feedback on the performance of alumni, narrative evaluation by students, and narrative evaluation of alumni. The results will enable the Executive Committee of the Bioengineering Graduate Program, the Department Heads, Director of the Graduate Program in Bioengineering, M.Eng. Coordinator, and faculty to make modifications as appropriate in a timely manner.

Financial Incentives for Students

We envision institution of a grant program to assist in attracting desirable students to the program, with a goal of increasing the quality and diversity of the student body. Quality students with significant work experience will be actively recruited. Financial assistance will be offered in the form of "Leadership Grants" which will be processed as an educational assistance grant.

Students who are awarded grants will be encouraged to participate in departmental activities which will aid in their leadership development. Examples include tutorial, administrative, consulting, or service activities; certain officer and committee chair positions for students (i.e. BIOE Graduate Program student advisory committee, seminar committee, social chair, etc.…); or special events such as new class orientation or alumni/employer relations.

Students in the program will not be eligible for tuition and fee waivers through separate research or teaching assistantship assignments. Students whose tuition is paid by their employer will not be eligible for financial incentives. The proposed grants will provide increased opportunities for ethnic/racial/gender minorities that are currently underrepresented.

Industry Advisory Board

As two of the core courses and the project require substantial involvement from engineers working in industry, it is essential to establish an Industry Advisory Board (IAB) to serve an active advising function and resource for the program. Through the many contacts of faculty

leaders at Illinois, high-level managers at several of the largest bioinstrumentation companies in the world have expressed enthusiasm for the proposed program, and have volunteered their expertise to help guide the program. The IAB will be consulted on a continuous basis regarding the topics of the BIOE 573 Biomedical Systems Engineering course, and will be asked to provide names of potential engineers within their organizations who can be recruited to develop and deliver course modules on topics for which they have unique expertise. A single IAB meeting per year will be held on the Illinois campus in conjunction with the presentation of project progress report presentations, so as to provide opportunities for the IAB to interact with students directly.

Several prestigious and accomplished people have already volunteered to serve as founding members of the IAB. Their names and affiliations are listed below:

1. Stuart Jackson (Founder and President, AnalyzeDirect)
2. Rob Gillio (Mayo Clinic)
3. Bruce Johnson (Mayo Clinic)
4. Camille Chang Gillmore (Boston Scientific)
5. Dave Markham (Lockheed Martin)
6. Frank Prendergast (Mayo Clinic)
7. Jim Martucci (Technical Director, Baxter Medical Products R&D)
8. Brian Knight (Siemens)
9. Peter Li (Founder, Nexcelom)
10. Merrell Magelli (Horizon Pharmaceuticals)
11. Peter Bonutti (Founder, Bonutti Technologies)

Of this group, several have expressed interest in teaching a course module of BIOE 573-575, to give guest lectures at the Bioinstrumentation seminar, and others have indicated willingness to recruit colleagues within their network. Response from Illinois Alumni has been especially enthusiastic.

Prof. Paul Magelli, founding faculty of the Illinois MBA program, has been serving as a strategic advisor for the M.Eng. Bioinstrumentation program, and will also participate in the IAB. Prof. Magelli has many contacts in the biomedical device/instrument business community, and experience in initiation of programs that cater to people seeking to advance their careers in industry.

Industry Coordinator
An Industry Coordinator is required to manage the relationship between the program and its various Industry participants. The Industry Coordinator will be responsible for organization of the IAB meeting, facilitating the participation of Industry instructors, organization of visits from Industry personnel who give seminars, and developing relationships with Industry recruiters for purposes of career services.

Enhanced Career Services
We believe that a characteristic of an outstanding program is an effective career placement program. We recommend that a portion of the program operating budget be used to support placement services. Services would include active solicitation from IAB member companies for information about available job openings, organization of an Industry Day during the Spring Semester during which companies will be invited to send recruiters, resume preparation services, and interview skill development services. This will include "co-curricular" activities that are non-graded, but meant to enhance the classroom and project experiences. Workshops on leadership

skills, improving interpersonal skills, communication skills, teamwork, and self-awareness will be components of this program. The program may also organize plant visits and other outreach with the business community.

Bioinstrumentation Boot Camp

We anticipate that many students enrolled in the program will be engineers who have been working in Industry for several years, or students who may be unfamiliar with certain core concepts that are typically covered only in 200-300 level courses. Therefore, the program will include an intensive 1-week, non-credit "refresher" experience during the new student week preceding the Fall semester. The week is called "Bioinstrumentation Boot Camp." We plan to provide the following activities that will serve to allow students to rapidly engage in the core curriculum while encouraging social interaction with classmates, faculty, and BIOE graduate students who are not enrolled in the Bioinstrumentation major:

- Review of key concepts of molecular biology and cell biology
    - Central dogma of Molecular Biology
    - DNA structure and function
    - Protein structure and function
    - Cell physiology
    - Organ physiology
- Review of key engineering concepts
    - Electrical circuits and resonators
    - Feedback and control systems
    - Signals and noise
    - Review of medical imaging modalities
    - Principles of fluorescence
    - Principles of label-free biosensors
- Each day will include a 2 hour "Bio" section
- Each day will include a 2 hour "Instrumentation" section
- Each day will include a social event
    - Serve to introduce students to the campus, faculty, and BIOE graduate students
- All meals provided
- No exams, homework assignments, or grades
- Participation is expected and encouraged of all students in the program
- Teaching materials assembled into a single binder for future reference

Online Availability of the Program

The program will initially be offered only to students who attend the classes and activities on campus. In order to engage students who are also managing careers and family, the program will consider approaches for offering educational content online, but currently there are no specific plans about how to do so.

BUDGETARY AND STAFF IMPLICATIONS:

a. Additional staff and dollars needed: Students in this program will be primarily self-supporting. The College of Engineering (CoE) has already developed an 80%/20% tuition distribution model (from the 90% of tuition returned to the College) for departments offering majors and concentrations within M.Eng, in which the Departments can utilize 80% of the tuition dollars CoE receives to support the costs of running the program. Tuition funds returned to the sponsoring departments will be used to cover the costs of developing required courses, and to compensate faculty and visiting lecturers who deliver course modules. Se attached MOU in Appendix D

   Bioengineering proposes that the major in Bioinstrumentation be self-supporting. A revenue/cost model has been prepared for the program which assumes that students will pay tuition/fees in the range of $40,000 (further study of the market and costs for operating the program is required, and consultation with the College is required before tuition rates can be set). Tuition funds will be used to support faculty time for the development and teaching of course modules (assuming 14 modules of faculty time per year) at a cost of $7000/module. Faculty time is paid in addition to their normal teaching loads in their home department (i.e. teaching a module in the M.Eng. program does not count towards a faculty member's ordinary teaching load, therefore compensation for their effort is applied on top of their regular salary). Funds will be allocated for honoraria for industry instructors to develop and teach course modules; travel reimbursement for guest lecturers; marketing; on-campus events; plant trip; and the IAB meeting. Funds will also be used to support two staff personnel – an administrative assistant and an industry coordinator.

b. Internal reallocations (e.g., change in class size, teaching loads, student-faculty ratio, etc.): The projected enrollment in the program is expected to begin small, with ~25 students in the first year. This estimate is based on the number of students already taking courses in biomedical imaging, biosensors, and biomedical instrumentation. In addition to the required courses (BIOE 570-575), the remaining credit hours in the major area are allocated among an extensive list of courses from the CoE and other units (See Appendix C). The projected enrollment is not expected to significantly impact CoE course enrollments. Tuition funds returned to the departments will be used to hire teaching assistants to support additional sections of courses as needed. We hope to grow the program to 40-50 students (steady state) by the 4th year of operation.

c. Effect on course enrollment in other units and explanations of discussions with representatives of those departments: With the expected number of students spread through courses distributed across the campus, it is not anticipated that additional course sections will be needed to accommodate the students in this major. Greater than half of the 40 hrs required are allocated among CoE rubrics and any additional resources required to support student enrollment would be funded by tuition distribution to participating departments per an MOU for CoE courses approved by the College (Appendix D). The remaining hours of the major are outlined in an extensive list of CoE elective courses (Appendix C). This provides the students ample opportunity to select courses that have open enrollment availability.

d. Impact on the University Library: None-Letter Provided

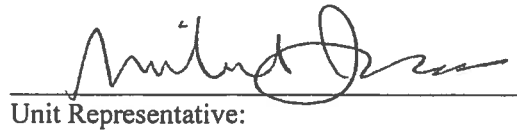
e. Impact on computer use, laboratory use, equipment, etc.: No additional impact on computer use, laboratory use, or equipment is expected.

DESIRED EFFECTIVE DATE: Fall 2015

STATEMENT FOR PROGRAMS OF STUDY CATALOG: Appendix B

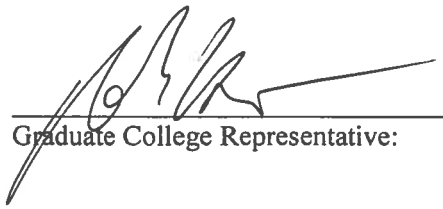
CLEARANCES:

Signatures:



Unit Representative: 9/13/2012 Date:

College Representative: 10/15/2013 Date:



Graduate College Representative: 3/10/2014 Date:

Council on Teacher Education Representative: Date:

Appendix A:
(Budgetary and Staff Implications)

New Degree Programs – Required Budgetary Implication Questions

1) How does the unit intend to financially support this program? The program will be self-supported from tuition dollars.

2) Will the unit need to seek campus or other external resources? The unit will seek a startup loan from the College to support costs of advance marketing the program. The program is soliciting bids for development of a web site, marketing materials, and an advertising campaign that is similar to what was performed in preparation for the first offering of the Illinois MBA Program. The loan will be repaid to the College in one year.

3) If no new resources are required, how will the unit create capacity or surplus to appropriately resource this program? (What functions or programs will the unit no longer support?) N/A.

4) Please provide a market analysis: What market indicators are driving this proposal? What type of employment outlook should these graduates expect? What resources will be required to assist students with job placement?

Due to the rapid growth of businesses in biomedical imaging, image processing, DNA diagnostics, personalized medicine based on biosensor tests, bioinformatics, and biomedical devices, we anticipate a strong need for highly trained students who can transition technology into products in this area.

The objective of the Illinois M.Eng. in Bioinstrumentation is to prepare a diverse set of men and women who have high potential to become and remain effective leaders in the development and commercialization of Bioinstrumentation technology in a global environment characterized by multidisciplinary teams, complex systems, and strict safety regulation. We know of no master's level Bioengineering-related programs that could be considered comparative to the one in this program proposal

The Department proposes to hire an industry coordinator whose duties will include developing relationships with industry recruiters for the purposes of enhancing career services currently offered by the Engineering Career Services office.

5) If this is a proposed graduate program, please discuss the programs intended use of waivers. If the program is dependent on waivers, how will the unit compensate for lost tuition revenue? This program will not utilize tuition waivers.

Appendix B:
Statement for the Programs of Study Catalog

New additions for the graduate POS for Bioengineering are shown below (with changed underlined). No other changes requested

Major: Bioinstrumentation
Degrees Offered: M.Eng.

Medical Scholars Program: Doctor of Philosophy (Ph.D.) in Bioengineering and Doctor of Medicine (M.D.) through the Medical Scholars Program

Graduate Degree Programs

The Department of Bioengineering offers studies leading to the Master of Engineering with a major in Bioinstrumentation, Master of Science in Bioengineering, and the Doctor of Philosophy in Bioengineering. The Bioengineering Graduate Program provides M.S. and Ph.D. students with educational and research experiences that integrate the sciences of biology and medicine with the practices and principles of engineering. Areas of focus include Bio-imaging, Cell & Tissue Engineering, Micro and Molecular Technologies, and Computational Biology. Opportunity also exists for specializing in (i) computational science and engineering and (ii) energy and sustainability engineering via the Computational Science and Engineering (CSE) Option and the Energy and Sustainability Engineering (EaSE) Option. The Medical Scholars Program permits highly qualified students to integrate the study of medicine with study for a graduate degree in a second discipline, including Bioengineering.

Admission

Applicants should have an undergraduate degree in a natural science, computer science, or engineering. A minimum grade point average of 3.00 (A = 4.00) for the last two years of undergraduate study is required. Applicants should show evidence of strong quantitative skills and of serious interest in the life sciences. Applicants with a grade point average of greater than 3.00 (A = 4.00) may be considered for admission to the Ph.D. program. In addition, applicants to the Ph.D. program must submit results from the Graduate Record Examination (GRE) general test. For the M.Eng. program, students must have had a B.S. degree in an engineering or related field. Students in the program are not expected to continue in and do not have automatic admission to the Ph.D. program in any engineering department. A new application must be submitted to the specific department of interest if a M.S. or Ph.D. degree is desired.

All applicants whose native language is not English must submit a minimum TOEFL score of 97 (iBT), 243 (CBT), or 590 (PBT); or minimum International English Language Testing System (IELTS) academic exam scores of 6.5 overall and 6.0 in all subsections. Applicants may be exempt from the TOEFL if certain criteria are met. For those taking the TOEFL or IELTS, full admission status is granted for scores of 103 (TOEFL iBT) or greater, 253 (TOEFL CBT), 610 (TOEFL PBT), or 6.5 (IELTS). Limited status is granted for lesser scores and requires enrollment in English as a Second Language (ESL) courses based on an ESL Placement Test (EPT) taken upon arrival to campus.

For the M.Eng. program, all applicants whose native language is not English must submit a minimum TOEFL score of 103 (iBT), 257 (CBT), or 613 (PBT); or minimum International English Language Testing System (IELTS) academic exam scores of 7.0 overall and 6.0 in all subsections. Applicants may be exempt from the TOEFL if certain criteria are met. Full admission status is granted for those meeting the minimum requirements of the TOEFL or IELTS since the scores required for admission to M.Eng. are above the minimum scores demonstrating an acceptable level of English language proficiency. GRE scores are not required for application.

Students may apply to the Medical Scholars Program prior to beginning graduate school or while in the graduate program. Applicants to the Medical Scholars Program must meet the admissions standards for and be accepted into both Bioengineering and the College of Medicine. An application to the Medical Scholars Program will also serve as the application to the Bioengineering graduate program. Further information on this program is available by contacting the Medical Scholars Program (125 Medical Sciences Building, 217-333-8146, mspo@illinois.edu).

Degree Requirements

*For additional details and requirements for all degrees, please refer to the department's Graduate Studies Web site and the Graduate College Handbook.

Master of Engineering, Bioinstrumentation

Requirements	
Credit Hours:	**Hours**
Total Credit for the Degree	***40***
Course Work	40
BIOE 570	2
BIOE 571, BIOE 572, BIOE 573, BIOE 574	16
Track Elective courses from approved list	12
BIOE 575	6
Free Elective	4
Other Requirements and Conditions:*	
The minimum program GPA is 3.0	

Financial Aid

Students in the Bioinstrumentation major for the M.Eng. degree are not eligible for tuition waivers through research assistantships or teaching assistantships.

Appendix C
Track and Breadth Elective Courses for Bioinstrumentation

Track 1 – Biomedical Imaging (12 hours)

ECE 410 – Digital Signal Processing
ECE 473 – Fundamentals of Engineering Acoustics
ECE 474 – Biomedical Ultrasound Imaging
ECE 545 – Advanced Physical Acoustics
ECE 480 – Magnetic Resonance Imaging
BIOE 581 – MRI Pulse Sequence Design
ECE 598ZPL – MRI Imaging II
ECE 467 – Biophotonics
ECE 558 – Digital Imaging

Track 2 – Life Science Tools (12 Hours)

BIOE/ECE 414 – Biomedical Instrumentation & Laboratory
BIOE/ECE 416 – Biosensors
ECE 437 – Sensors and Instrumentation
ECE 460 – Optical Imaging
ECE 564 – Modern Light Microscopy
BIOE 507 – Advanced Bioinstrumentation

Approved Breadth Electives (4 hours)

Business and Entrepreneurship
GE 400 – Engineering Law
ABE 430 – Project Management
ENG 461 – Technology Entrepreneurship
ENG 465 – Business Technical Consulting
ENG 466 – High-Tech Venture Marketing
ENG 560 – Managing Advanced Technology
ENG 565 – Technology Innovation and Strategy
ENG 566 – Finance for Engineering Management
ENG 567 – Venture-Funded Startups

Electromagnetic and Acoustic Waves
ECE 450 – Lines, Fields, and Waves
ECE 455 – Optical Electronics
ECE 520 – Electromagnetic Waves and Radiating Systems
ECE 540 – Computational Electromagnetics
ECE 473 – Fundamentals of Engineering Acoustics
ECE 545 – Advanced Physical Acoustics

Image Processing, Signal Processing, and Numerical Analysis
ECE 410 - Digital Signal Processing
ECE 418 - Introduction to Image and Video Processing
ECE 420 - Digital Signal Processing Laboratory

ECE 544 – Topics in Signal Processing
ECE 547 – Topics in Image Processing
ECE 551 – Digital Signal Processing II
ECE 558 – Digital Imaging
ECE 561 – Detection and Estimation Theory
ECE/CS 491 – Numerical Analysis
ECE 493 – Advanced Engineering Math
CS 411 – Database Systems
CS 473 – Algorithms

Chemical, Molecular, and Cellular Biology
BIOE 506 – Molecular and Cellular Bioengineering
BIOP 590M – Biophysics of Membrane Proteins
BIOP 540 – Topics in Biophysical Chemistry
CHBE 472 – Techniques in Biomolecular Engineering
CHBE 473 – Biomolecular Engineering
BIOP 420 – Molecular Biophysics
BIOP 540 – Topics in Biophysical Chemistry
BIOP 550 – Biomolecular Physics

Biomedical Imaging
ECE 472 – Biomedical Ultrasound Imaging
ECE 480 – Magnetic Resonance Imaging

Sensors and Instrumentation
BIOE/ECE 414 – Biomedical Instrumentation
BIOE/ECE 415 – Biomedical Instrumentation Laboratory
BIOE/ECE 416 – Biosensors
ECE 437 – Sensors and Instrumentation
ECE 485 – Introduction to MEMS
BIOE 507 – Advanced Bioinstrumentation
ECE 515 – Control System Theory & Design
ECE 517 – Nonlinear & Adaptive Control
ECE 528 – Analysis of Nonlinear Systems
CHBE 553 – Surface Chemistry
ME 598 – Mechanics of MEMS
ME 487 – MEMS-NEMS Theory & Fabrication
ECE 481 – Nanotechnology
ECE 484 – Principles of Advanced Microelectronic Processing
ECE 485 – Introduction to MEMS
ECE 510 – Micro and Nanolithography
ECE 536 – Integrated Optics and Optoelectronics
ECE 598JL – Advanced Nanotechnology

Biophotonics
ECE 467– Biophotonics
ECE 460 – Optical Imaging
ECE 495 – Photonic Device Laboratory
ECE 564 – Modern Light Microscopy
ECE 569 – Coherence, Diffraction, and Information
ECE 570 – Nonlinear Optics

Neuroscience
BIOP 417 – Modeling Neural Systems
BIOP 419 – Brain, Behavior, & Information Processing

Bioinformatics
ANSC 542 – Applied Bioinformatics
ANSC 545 – Statistical Genomics
CS 466 – Introduction to Bioinformatics
BIOP 590B – Bioinformatics

Appendix D
Financial Model

Two example financial models are shown, to enable visualization of the impact of enrollment, staff support, instructor salaries, marketing costs, overhead, and fees taken by the University and by the College. Both models assume tuitions and fees of $39,850/year, selected based upon tuition assessed at competing institutions. The first model assumes an enrollment of 25 students. The second model assumes an enrollment of 40 students. Both models project that the program will be net revenue-generating.

Additional comments:

- The level of required TA support has not yet been determined
- Cost of $200 per instructional unit (IU) has been negotiated by the College of Engineering for any CoE elective courses taken outside the BioE Department (see attached MOU)
- Prof. Brian Cunningham will be serving in the role as the founding Director of the M.Eng. Bioinstrumentation program, and will also be serving as an instructor. No compensation for a Director salary is currently included in the budget. Within BioE, the Graduate Program Coordinator receives a salary bonus of $3000/year for performing this role, and the Director of the M.Eng. will always be a fully tenured BioE faculty member compensated at a similar level.

Table D1: Financial model assuming enrollment of 25 students

M.Eng. Financial Model					
Number of Students	25				
Tuition	39850				
Fee					
Revenue to College	896625	90% to College, 10% taken by University			
Revenue to Program	**717300**	CoE takes 20%, rest available to program			
Engineering Faculty					
Faculty Module Payment	7000	Paid in addition to regular service, no overhead			
Number of Faculty Modules	14				
Faculty Cost	**98000**				
Staff					
Industry Coordinator	60000	Salary before overhead			
Admin Assistant	40000	Salary before overhead			
Total	100000				
Total with Overhead	**100000**	No overhead/fringe on State Funds			
Business School & Industry Faculty					
Faculty Module Payment	7000				
Number of Faculty Modules	14				
Faculty Cost	**98000**				
Teaching Assistants	**25000**	Estimate: Actual level of TA support not yet determined			
Miscellaneous					
Marketing	20000	web site, brochures, travel, Google			
IAB Meeting	20000				
Plant Trips	5000				
On-campus events	5000				
Grants					
Boot Camp	10000				
Courses outside program	80000	Blanket MOU = $200/instructional unit			
Guest speaker support	15000	travel reimbursement			
Total	**155000**				
			200	$/credit hour	
Total Costs	**476000**		16	Elective hours	
			25	Students	
Revenue - Cost	241300		**80000**	**Amount Sent to Departments**	
Revenue/Student	9652				

Table D2: Financial model assuming enrollment of 40 students

M.Eng. Financial Model					
Number of Students	40				
Tuition	39850				
Fee					
Revenue to College	1434600	90% to College, 10% taken by University			
Revenue to Program	**1147680**	CoE takes 20%, rest available to program			
Engineering Faculty					
Faculty Module Payment	7000	Paid in addition to regular service, no overhead			
Number of Faculty Modules	14				
Faculty Cost	**98000**				
Staff					
Industry Coordinator	60000	Salary before overhead			
Admin Assistant	40000	Salary before overhead			
Total	100000				
Total with Overhead	**100000**	No overhead/fringe on State Funds			
Business School & Industry Faculty					
Faculty Module Payment	7000				
Number of Faculty Modules	14				
Faculty Cost	**98000**				
Teaching Assistants	**25000**	Estimate: Actual level of TA support not yet determined			
Miscellaneous					
Marketing	20000	web site, brochures, travel, Google			
IAB Meeting	20000				
Plant Trips	5000				
On-campus events	5000				
Grants					
Boot Camp	10000				
Courses outside program	128000	Blanket MOU = $200/instructional unit			
Guest speaker support	15000	travel reimbursement			
Total	**203000**				
			200	$/credit hour	
Total Costs	**524000**		16	Elective hours	
			40	Students	
Revenue - Cost	623680		**128000**	**Amount Sent to Departments**	
Revenue/Student	24947.2				

Tuition Distribution MOU for Master of Engineering
COE Approved October 2013

TO: **Rashid Bashir**
Department Head
Department of Bioengineering

FROM: **Victoria Coverstone** Victoria L. Coverstone
Associate Dean
Graduate and Professional Programs

SUBJECT: **Tuition Distribution for Master of Engineering**

DATE:

This Memorandum of Understanding (MOU) is between the College of Engineering (CoE) and its Departments participating in Master of Engineering (M.Eng.) programs. The CoE agrees to distribute graduate tuition received from campus (net of campus overhead, which is currently 10% of total graduate tuition) for students enrolled in M.Eng. programs as follows.

20%: To CoE
20%: To the M.Eng. designated home unit
$200/Grad IU: To CoE rubrics outside of the M.Eng. designated home unit that provide graduate instructional units (IU---1 Grad IU is assumed equivalent to 1 credit hour)

Any tuition remaining after the above allocations are made will be distributed to the M.Eng. designated home unit.

Example of M.Eng Distribution

Projected student enrollment	20
Tuition per student	$16,754
Total IU's for M.Eng. Program	32
IU's in secondary unit(s)	8

		Allocation	Remainder	%
Total Tuition		**$ 335,080**		
10% Campus		$ 33,508	*$ 301,572*	10%
College - 20% net campus overhead		$ 60,314	*$ 241,258*	18%
M.Eng. Home Department - 20% net campus overhead		$ 60,314	*$ 180,943*	18%
Departments providing courses:*				
Based on $200 per IU for secondary unit (s), remainder to home unit*				
Secondary CoE Unit IUs	8	$ 32,000	*$ 148,943*	10%
M.Eng. Home Unit IUs	24	$ 148,943		44%
Total Tuition to M.Eng. Home Unit		$ 209,258		62%

Tuition Distribution MOU for Master of Engineering
COE Approved October 2013

In previous tuition distribution agreements for master's degree programs in the CoE, departments were only eligible for tuition distribution for programs that were distinctly different than the traditional master's degree program offered by that department; i.e. attracting incrementally new students than the traditional degree, and tuition was distributed after a "baseline" of tuition garnered from the existing program was determined. Departments operating under this MOU will receive a $0 baseline. In order to be eligible to receive tuition under this MOU, departments must also adhere to the following assumptions:

1) M.Eng. programs can be designated as self-supporting. Even for programs that are not designated as self-supporting, it is assumed that the majority of students enrolled in M.Eng. programs will pay full tuition.
2) M.Eng. programs can set tuition rates greater than standard campus graduate tuition. Justification including proposed program costs, student demand, and competitor information must be provided with the request for differential tuition. CoE Administration must approve the request before it is forwarded to campus for review. Contact Elizabeth Stovall in the Office of Graduate and Professional Programs, estovall@illinois.edu.
3) The CoE department designated as the M.Eng. home unit (Major or Concentration) is responsible for ensuring the availability of required courses. Tuition flow to CoE departments/units of course rubrics outside of the M.Eng. home unit, but within the CoE, will follow the tuition distribution model outlined above. For elective courses with open enrollment, it is assumed that enrollment issues can be handled via advising.
4) M.Eng. programs designated as self-supporting must obtain prior CoE approval to offer scholarships to students enrolled in M.Eng. programs. Contact Elizabeth Stovall in the Office of Graduate and Professional Programs, estovall@illinois.edu. The resulting decrease in tuition revenue from scholarships will impact funds available to distribute to CoE external units providing courses, however, the obligation at the $200/Grad IU standard rate remains.
5) M.Eng. programs not designated as self-supporting may experience students enrolling who have obtained tuition waivers from other units. The resulting decrease in tuition revenue will impact funds available to distribute to CoE external units providing courses, however, the obligation at the $200 /Grad IU standard rate remains.

If a unit is already receiving tuition distribution for a master's degree program in the CoE, an addendum to this MOU will be drafted in order to address the "baseline" that will be used, as well as any other issues that might need to be addressed during the transition to the M.Eng. program.

This agreement will remain in effect for three years, after which time it will be reviewed, and must be renewed.

Tuition Distribution MOU for Master of Engineering
COE Approved October 2013

Addendum for CoE Departments providing courses external to the M.Eng. designated home unit

To:	CoE Department Head(s), CoE Department(s)
From:	M.Eng. Major/Concentration Home Unit
Re:	M.Eng. (specify Major/Concentration)

Tuition received by the College of Engineering (CoE) for students enrolled in M.Eng. programs will be distributed to CoE departments (external to the designated home unit) which provide courses required for the M.Eng. degree program listed above at the rate of $200/Grad IU, where 1 Grad IU is assumed equivalent to 1 credit hour. Tuition will be distributed to units at the end of the fiscal year based on 10-day enrollment data of each semester.

Tuition distribution is to be used to provide instructional resources needed to support the offering of course(s) to M.Eng. students. Department(s) named above offering course(s) for the M.Eng. degree program referenced in this MOU agree to provide enrollment for M.Eng. students in these course(s), at the level projected in the M.Eng. program proposal; in the same instruction format in which is the course is typically offered (e.g. instructor, class schedule, etc.) with instructional quality consistent with offerings of the course(s) prior to the enrollment of M.Eng. students. M.Eng. programs will be reviewed annually for the first three years to evaluate student enrollment, course availability, student/faculty ratios, and student/faculty assessment (by survey or other means). After the initial three years, the programs will be reviewed every three years.

Signatures

M.Eng. designated home unit:

Bioengineering

Department	Authorized Signature

CoE Department offering courses: (ECE410, 472, 473, 474, 545, 480, 581, 598ZPL, 467, 558, 414, 437, 460, 564, 450, 455, 520, 540, 473, 545, 410, 418, 420, 544, 547, 551, 558, 561)

Electrical and Computer Engineering

Department	Authorized Signature

Appendix E
New Course Descriptions

BIOE 570 Bioinstrumentation Seminar
Lecture and discussion on topics relevant to the development, regulatory approval, marketing, and application of systems used in the fields of biomedical imaging, life science research, pharmaceutical discovery, agriculture, food safety, and environmental monitoring. Emphasis upon case studies on topics that will include regulatory approval, intellectual property, strategy, and technology innovation.

BIOE 571 Principles of Bioinstrumentation I
Introduce concepts related to the detection and analysis of biological analytes, biomedical images, and physiological parameters. Topics include signal-to-noise analysis, noise characterization, data aliasing, analog-to-digital conversion, and common strategies for noise reduction. The fundamental phenomena behind biological measurements such as DNA sequencing, fluorescence microscopy, MRI imaging, OCT imaging, and ultrasound imaging will be discussed, along with the factors that influence noise and contrast from the standpoint of fundamental physics, instrumentation/hardware, and post-measurement data/signal processing.

BIOE 572 Principles of Bioinstrumentation II
Introduce concepts related to the detection and analysis of biological analytes, biomedical images, and physiological parameters. Topics include signal-to-noise analysis, noise characterization, data aliasing, analog-to-digital conversion, and common strategies for noise reduction. The fundamental phenomena behind biological measurements such as DNA sequencing, fluorescence microscopy, MRI imaging, OCT imaging, and ultrasound imaging will be discussed, along with the factors that influence noise and contrast from the standpoint of fundamental physics, instrumentation/hardware, and post-measurement data/signal processing.

BIOE 573 Biomedical Systems Engineering
Introduce business practices and engineering methods that are used in development of products for biomedical imaging and biological measurement. Topics include development of product requirements, product risk analysis, tracing requirements to design, six-sigma quality control, regulatory issues, software validation, and product life cycle. The course will include presentation and discussion of case studies provided by Industry guest lecturers.

BIOE 574 Biomedical Business Issues
Introduce business practices and engineering methods that are used in development of products for biomedical imaging and biological measurement. Topics include project management, using technology to manage clinical processes, managing product complexity, hardware validation, and interface design for the clinic. The course will include presentation and discussion of case studies provided by Industry guest lecturers.

BIOE 575 Bioinstrumentation Project

Capstone bioinstrumentation design activity developing project solutions appropriate for academic, industrial, or clinical settings, utilizing principles of design, engineering analysis, and functional operation of engineering systems. Focus on concept-design, safety, human-factors, quality, design for requirements, regulatory strategy, and Six-Sigma considerations.

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

University Library
Office of Dean of Libraries
and University Librarian
230 Main Library, MC-522
1408 West Gregory Drive
Urbana, IL 61801

October 2, 2013

Victoria L. Coverstone
Associate Dean, Office of Graduate and Professional Programs
College of Engineering
401 Engineering Hall
MC-266

Dear Dean Coverstone:

Thank you for providing the University Library with the opportunity to review the College of Engineering's proposal to the Senate Committee on Educational Policy to establish a major in Bioinstrumentation for the degree of Master of Engineering. Based upon the proposal that we reviewed, we do not believe that there will be any substantive impact on existing library offerings—either in terms of library materials or personnel.

The librarians in the Grainger Engineering Library have an excellent relationship with the College and if additional services or materials are required as the program develops, I have every confidence that we will be able to work together to meet the needs of the students.

Sincerely,

John P. Wilkin
Juanita J. and Robert E. Simpson
Dean of Libraries and University Librarian

c: Thomas Teper
William Mischo
Mary Schlembach
Elizabeth Stovall, Graduate Programs Director, CoE

telephone 217-333-0790 • *fax* 217-244-4358

UNIVERSITY OF ILLINOIS
AT URBANA - CHAMPAIGN

Department of Bioengineering
1270 Digital Computer Laboratory
1304 West Springfield Avenue
Urbana, IL 61801

January 6, 2014

Debasish Dutta
Dean of the Graduate College
204 Coble Hall
MC 322

Dear Dean Dutta

I am writing to request Self-Supporting status for the Master of Engineering in Bioinstrumentation degree. The proposal is sponsored by the Department of Bioengineering and is currently being reviewed by the Graduate College.

The justification form is attached. At this time, the Department would also like to request a "differential" tuition of $39,850 for this program. A summary of tuition charged at competitor institutions for similar programs is provided as well as a projected program budget.

Sincerely,

Brian T. Cunningham
Encl:

telephone 217-333-2301 • *fax* 217-244-7075

JUSTIFICATION FORM

Please complete one form for each degree program for which a change is sought effective for students entering in fall 2013, including:

1. **a change in waiver level for assistantship appointments;**
2. **a change to requesting reimbursement for the value of assistantship waivers from outside appointments;**
3. **a change in program status to self-supporting;**
4. **a change in waiver level for college-awarded stand-alone waivers.**

COLLEGE OR SCHOOL: College of Engineering

PROGRAM: Master of Engineering in Bioinstrumentation

PROGRAM CODE: tbd

1. **Describe here or on an attached sheet the academic reasons for this request and explain: (a) why the proposed change will not adversely affect the general welfare of graduate students in the unit, including underrepresented students, and (b) how the proposed measures will improve or be neutral with respect to the academic quality of the program.**

   (a)The purpose of the request to designate this program as self-supporting to actually to alleviate the potential to adversely affect the general welfare of graduate students in the department. The Master of Engineering in Bioinstrumentation is a new professional degree program. It is not considered in any way to be appropriate preparation for a Ph.D. This new degree will distinguish itself from the existing M.S. with thesis program and M.S. non-thesis program (available to Bioengineering B.S. graduates only). The program requires additional costs to support the curriculum that are not included in our traditional MS program. There is significant participation expected from industry which will require travel and programmatic expenses as well as a full-time staff member to manage the industrial relationships. The program cannot be maintained if tuition revenue is not collected. Graduate students understand (when explained) what a self-supporting program means. Given any other circumstance, students will try to obtain assistantships which will provide for their tuition; causing the program to forego the tuition. Self-supporting status sets clearer expectations with regard to the applicability of assistantships which provide for tuition. The Department has planned to include leadership grants to assist with tuition costs to promising students and will use these specifically to recruit underrepresented students. In addition, as relationships with industry are established, the hope is that industrial support will be available to assist students as well.
   (b) Ensuring that tuition is returned to the department will maintain the quality of the program. If expected tuition revenue is not obtained then several facets of the program will be impacted regarding the availability of course enrollments, industry lecturers, program expenses, and staff support.

2. **Describe the expected impact of the proposed change on new students. How will these measures affect the affordability of the program? What type of financial aid, if any, will be offered? Note: continuing students will not be affected as they are subject to the rules in effect at the time of their admission.**

   The department is asking for a "differential" graduate tuition of $39,850. This is commensurate with what is charged by our competitors for similar degree program. The Bioinstrumentation major is an accelerated program that can be completed in one full academic year (including summer) so that working professional who need to upgrade their skill set do not have to be out of the job market for an extended period. New students will be aware of the tuition up front and be able to

University Name	Univ of Illinois	AVERAGE Of Other Schools	Georgia Tech	UC-Riverside	MIT	Duke	Northwestern	Texas Tech	UIC	Stevens IT	UC-Berkley	UCSD	Johns Hopkins
Program Name	M.Eng. in Bioinstrumentation	* Note that the average is only for schools where information is available					tied to phD, not really a Meng			Master of Engineerinf - Biomedical Engineering		Master of Advanced Study	Engineering for Professionals
Location	Urbana, IL												
Website			http://www.catalog.gatech.edu/colleges/coe/bmed/grad/ms.php	http://www.msol.ucr.edu/	http://odge.mit.edu/gpp/degrees/masters/master-of-engineering/	http://meng.pratt.duke.edu/biomedical	http://www.biotechtraining.northwestern.edu/	http://www.depts.ttu.edu/coe/academics/healthcare_engineering/index.php	http://www.uic.edu/eng/meng/BIOE.htm	http://www.stevens.edu/sit/graduate/master-of-engineering-biomedical-engineering.cfm	http://bioeng.berkeley.edu/meng	http://www.be.ucsd.edu/graduate_programs_master_eng_degree	http://ep.jhu.edu/graduate-programs/applied-biomedical-engineering
Year Program Began	2014	2012	2013	2013		2010							
Program Type	FT		FT										
Full-Time Resident		$40,095	$38,456	$30,000	$45,478	$66,060		$31,593	$27,972	$40,200*	$48,202	$33,000	$33,300*
Part-Time Resident											$2,200		
Full-Time Non-Resident		$54,041	$56,276								$51,807		
Part-Time Non-Resident											$2,200		
Duration				9 course online								36 Units	10 courses
Full Time (# of months)		13	12	24	9	16		12	12	9	9		
Admissions Stats													
Number of Students Enrolled		45	20-40			45							
Number of Full-Time Students		45				45							
Placement Rates (within 6 mo.)						80%							
Average Starting Salary						$78,200							

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Department of Business Administration
College of Business
350 Wohlers Hall
1206 South Sixth Street
Champaign, IL 61820-6980

December 5, 2013

Dear Graduate College Review Committee,

I am writing this letter in support of Professor Brian Cunningham's proposed Masters in Engineering—Bioinstrumentation Program. Professor Raj Echambadi, who is a member of my faculty, has been working closely with Professor Cunningham to develop the curriculum for this new program. Professor Echambadi has helped develop outlines for two proposed courses that will be taught by our faculty as part of this program. My understanding is that the first class of incoming students will enter in Fall 2015.

Several of my faculty have expressed interest in teaching in this program, including Professor Gopesh Anand, Professor Dilip Chhajed, Professor Raj Echambadi, Professor Paul Magelli, Profoessor Alex Sleptsov, Professor Deepak Somaya, and Professor Fataneh Taghoboni-Dutta. These faculty understand that this teaching will be in addition to their normal teaching load. Their involvement will consist of developing highly targeted course "modules" that will be delivered on consecutive Saturdays, thus minimizing disruption to their normal teaching routines. Furthermore, this modular approach allows faculty to teach subjects in which they are already world-class experts, thus enabling them to prepare material based upon topics that they speak about regularly. Faculty participation in teaching above their normal course load will be compensated by the M.Eng program in the form of service-in-excess payments, which also helps the faculty justify their time and effort, as it takes time away from family and other professional activities. As the program moves forward, I will encourage new faculty to also become involved in order to maintain a strong representation from my department, which will help sustain this program.

If I can be of further assistance, please let me know (aric@illinois.edu).

Sincerely,

Aric Rindfleisch
Head, Department of Business Administration
College of Business

telephone 217-333-4240 • fax 217-244-7969

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Department of Bioengineering
College of Engineering
1270 Digital Computer Laboratory, MC-278
1304 West Springfield Avenue
Urbana, IL 61801

December 2, 2013

Dear Graduate College Review Committee:

As the head of one of the Departments who plan to participate in offering the M.Eng. Bioinstrumentation program to its first class of incoming students in Fall 2015, I have worked closely with Prof. Brian Cunningham (Director of the M.Eng. Bioinstrumentation Program) to shape the curriculum and format of the new degree over the course of the past year. The faculty in my department have participated enthusiastically in the conception of the program, and in the detailed outline of the syllabi of several new courses. From the beginning, the faculty have understood that teaching in the M.Eng. program is in addition to their normal teaching load, but that their involvement will consist of developing ~2 highly targeted course "modules" (one per semester) that will be delivered on consecutive Saturdays, thus minimizing disruption to their normal teaching routines. Further, the modular approach allows faculty to teach subjects in which they are already world-class experts, thus enabling them to prepare material based upon topics that they speak about regularly. Faculty participation in teaching above their normal course load will be compensated by the program in the form of honoraria, which also helps the faculty justify their time and effort, as it takes time away from family and other activities.

The following faculty have already expressed willingness to participate as M.Eng. Bioinstrumentation faculty:

Prof. Rohit Bhargava (BioE)
Prof. Stephen Boppart (ECE and BioE)
Prof. Brian Cunningham (ECE and BioE)
Prof. Michael Insana (BioE)
Prof. Su-A Myong (BioE)
Prof. Michael Oelze (ECE)
Prof. Gabriel Popescu (ECE)
Prof. Brad Sutton (BioE)
Prof. Jian Ma (BioE)

As the program moves forward, I will encourage new faculty to also become involved, so as to maintain a strong representation from my department in order to sustain the program.

Sincerely,

Rashid Bashir, Ph.D.
Head, Bioengineering Department
Professor, Department of Electrical and Computer Engineering & Bioengineering
Director, Micro and Nanotechnology Laboratory
University of Illinois at Urbana-Champaign
208 North Wright Street, Urbana, Illinois 61801 USA

Office (217) 333-1867, fax (217) 265-0246, Cell (217) 722-4250
rbashir@illinois.edu

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Office of the Provost and Vice Chancellor
for Academic Affairs

Swanlund Administration Building
601 East John Street
Champaign, IL 61820

March 21, 2014

Gay Miller, Chair
Senate Committee on Educational Policy
Office of the Senate
228 English Building, MC-461

Dear Professor Miller:

Enclosed is a copy of a proposal from the College of Engineering and the Graduate College to establish an MENG in Bioinstrumentation.

The proposal has been reviewed and approved by the College of Engineering Executive Committee as well as the Graduate College Executive Committee. It now requires Senate review.

Sincerely,

Kristi A. Kuntz
Assistant Provost

Enclosures

c: W. Buttlar
B. Cunningham
M. Lowry

telephone (217) 333-6677 • *fax* (217) 244-5639

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

Graduate College

204 Coble Hall
801 South Wright Street
Champaign, IL 61820-6210

March 7, 2014

Kristi Kuntz
Office of the Provost
207 Swanlund MC-304

Dear Kristi,

Enclosed please find the proposal seeking to establish a Major in Bioinstrumentation for the degree of Master of Engineering, College of Engineering.

The Graduate College Executive Committee has approved this proposal. I send it to you now for further review.

Sincerely,

John C. Hart
Associate Dean, Graduate College

c: A. Edwards
A. Kopera
M. Lowry

UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN

College of Engineering
306 Engineering Hall, MC-266
1308 West Green Street
Urbana, IL 61801

October 15, 2013

Associate Dean Alejandro Lugo
Graduate College
204 Coble Hall
MC-322

Via: Andreas Cangellaris, Engineering College

Dear Dean Lugo:

The College of Engineering Executive Committee has reviewed and approved the following proposals:

New ~~Course~~ MAJOR: "Major in Bioinstrumentation for the degree of Master of Engineering, College of Engineering"

Attached is a copy of the requests.

Sincerely yours,

John C. Hart, Vice Chair
Executive Committee

Approval Recommended:

Andreas Cangellaris, Dean
College of Engineering

10-15-2013
Date

JH/rd

Enclosure

c: Victoria Coverstone
Rashid Bashir
Brian Cunningham
Elizabeth Stovall

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Senate Educational Policy Committee
Proposal Check Sheet

PROPOSAL TITLE (Same as on proposal): Establish a Major in Bioinstrumentation for the degree of Master of Engineering, College of Engineering

PROPOSAL TYPE (Please select all that apply below)**:**

A. ☒ **Program and degree proposals**

1. This proposal is for a graduate program or degree

   ☒ Yes ☐ No

2. **Degree** proposal (e.g. B.S., M.A. or Ph.D.)

   ☐ New degree — please name the new degree:

   ☐ Revision of an existing degree — please name the existing degree to be revised:

3. **Major** proposal (disciplinary focus, e.g., Mathematics)

   ☒ New major — please name the new major: Bioinstrumentation

   ☐ Revision of an existing major — please name the existing major to be revised:

4. **Concentration** proposal (e.g. Financial Planning)

   ☐ New concentration — please name the new concentration:

   ☐ Revision of an existing concentration — please name the existing concentration to be revised: _____

5. **Minor** proposal (e.g. Cinema Studies)

   ☐ New minor — please name the new minor: _____

   ☐ Revision of an existing minor — please name the existing minor to be revised: _____

6. ☐ Proposal for renaming an existing degree, major, concentration, or minor

   ☐ degree ☐ major ☐ concentration ☐ minor

   Please provide the current name: _____

   Please provide the proposed new name: _____

7. ☐ Proposal for terminating an existing degree, major, concentration, or minor

   Please name the existing degree, major, concentration, or minor: _____

8. ☐ Proposal for a multi-institutional degree between Illinois (UIUC) and a foreign institution

   Please name the existing Illinois degree or program: _____

   Please name the partnering institution: _____

B. ☐ **Proposal for renaming existing academic units** (college, school, department, or program)

   Please provide the unit's current name: _____

   Please provide the unit's proposed new name: _____

C. ☐ **Proposal for reorganizing existing units** (colleges, schools, departments, or programs)

   ☐ Change in status of an existing and approved unit (e.g. change from a program to department) — please indicate current unit name including status: _____

   ☐ Transfer an existing unit

   Please provide the current unit's name and home: _____

   Please provide the new home for the unit: _____

   ☐ Merge two or more existing units (e.g., merge department A with department B)

   Please provide the name and college of unit one to be merged: _____

   Please provide the name and college of unit two to be merged: _____

   ☐ Terminate an existing unit — please provide the current unit's name and status: _____

D. ☐ **Other educational policy proposals** (e.g., academic calendar, grading policies, etc.)

   Please indicate the nature of the proposal: _____